



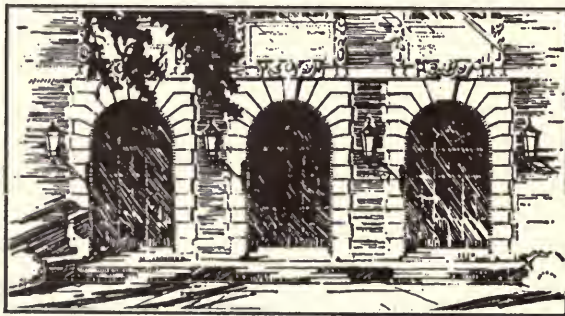
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A STUDY OF THE DIURNAL SQUIRRELS,  
SCIURINAE,

OF THE INDIAN AND INDOCHINESE SUBREGIONS

JOSEPH CURTIS MOORE

AND

GEORGE H. H. TATE

FIELDIANA: ZOOLOGY

VOLUME 48

*Published by*

CHICAGO NATURAL HISTORY MUSEUM

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# FIELDIANA: ZOOLOGY

*A Continuation of the*

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FIELD MUSEUM OF NATURAL HISTORY

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VOLUME 48



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CHICAGO, U. S. A.

1965



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SCIURINAE,

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A STUDY OF THE DIURNAL SQUIRRELS,  
SCIURINAE,

OF THE INDIAN AND INDOCHINESE SUBREGIONS

JOSEPH CURTIS MOORE

*Curator, Division of Mammals*

AND

GEORGE H. H. TATE

*The Late Curator of Mammals,  
American Museum of Natural History*

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## INTRODUCTION

The present study was initiated in connection with the identification of a large collection of Oriental squirrels acquired by the Archbold Expeditions of the American Museum of Natural History. Contemplating a taxonomic review of the Oriental squirrels, Dr. George Tate undertook to re-examine and attempt to identify with the population to which it belongs, each of the approximately 700 accessible type specimens of squirrels from southeastern Asia and the East Indies. This study involved visiting many of the museums in which the types are deposited, and these visits included study of extensive additional collections of Oriental squirrels. Procedure consisted of vocally recording new observations on the types in American and European museums, of photographing the skulls of types, and of making detailed measurements of them. Comparative observations on other specimens of Oriental squirrels in European museums in 1951 were also recorded. In some instances specimens were sent on loan for examination (by Tate).

Dr. George H. H. Tate died in December of 1953. The other author (Moore) was invited to put the manuscript on the Oriental squirrels into final form for publication. Gradually he found that the manuscript treatment of many genera could not be put into form for publication by editing. He then undertook to change the concept of the paper from a review to a substantial revision based on Tate's transcribed observations of European material and new study of about 8000 Oriental squirrel specimens in museums in the United States. Beginning in September, 1957, grants were solicited from federal agencies, but not for the preparation of a taxonomic revision alone. It was pointed out that this is a study of a subfamily of terrestrial mammals unusually variable in color, in a geographic area of exceedingly varied land form and extraordinarily active orogeny and erosion. Federal support of the morphological study and revision was sought and obtained on the grounds that they will reveal evidence on the evolution of the animals in relation to land forms and water barriers and thus may be important to evolutionary theory.

Discoveries of special taxonomic importance in this revisionary work have led to several separately published contributions. One is

a classification of the diurnal squirrels of the world (Moore, 1959). Another is an assessment of the taxonomic importance of the number of pairs of functional mammae in the Sciurinae and also the relationship of this character in Sciurinae to climate and to size of broods (Moore, 1961a). The strengthening of the classification of the living Sciurinae provided in these two papers invited consideration of the evolutionary implications of the geographic distribution of the morphological characters observed. These implications have been treated in part in the 1959 paper that offered the classification, in part in a paper on the distribution of squirrels in the Indian Sub-region (Moore, 1960), and further in a discussion of spreadings across the Bering and Panamanian land bridges (Moore, 1961b).

The use of the plural pronoun "we" should not confuse the reader who has read the above chronology of authorship. The "we" is usually meant only to imply participation of both authors in obtaining and collating the information and is not intended to place final responsibility for decisions on more than one pair of shoulders. Virtually no decision or opinion stated is Tate's alone unless so indicated in text except for ones that could only have been his because they could have been reached only by a study of the material in European museums.

#### ACKNOWLEDGMENTS

One or both of the authors are indebted to the following persons in the United States who have welcomed us to their offices and provided us access to the study collections in their charge: Dr. David H. Johnson, United States National Museum, Washington, D.C.; the late Colin C. Sanborn and Mr. Philip Hershkovitz, Chicago Natural History Museum, Chicago, Illinois; Miss Barbara Lawrence, Museum of Comparative Zoology, Cambridge, Massachusetts; Dr. H. Radclyffe Roberts (and Dr. Karl F. Koopman, formerly of) Academy of Natural Sciences, Philadelphia, Pennsylvania; and Dr. W. H. Burt and Dr. Emmett T. Hooper, Museum of Zoology, University of Michigan, Ann Arbor.

In Europe the following persons extended similar courtesies and privileges to Tate or helped us with loans and information, for which we both express our appreciation here: Mr. T. C. S. Morrison-Scott and Mr. R. W. Hayman, both of the British Museum (Natural History), London; M. Jean Dorst, Muséum National d'Histoire Naturelle, Paris; Count Nils Gyldenstolpe, Royal Natural History Museum, Stockholm; Dr. L. Forcart, Naturhistorisches



Museum, Basel; Dr. A. M. Husson, Rijksmuseum van Natuurlijke Historie, Leiden; Dr. E. Stresemann, Mr. K. Zimmermann, and Dr. W. Meise, Zoologisches Museum der Humboldt Universität, Berlin; Dr. R. Mertens, Senckenbergisches Naturforschende Gesellschaft, Frankfurt-am-Main; Dr. C. Stop-Bowitz, Universitetets Zoologiske Museum, Oslo; Dr. A. Holm, Zoologiska Institutionen, Uppsala; and the late Mr. H. J. V. Sody, of Amsterdam.

For loans of important material from museums in the Oriental Region we are grateful to the late Dr. Sunder Lal Hora and to Dr. Biswamoy Biswas, both of the Zoological Survey of India; to Mr. Humayun Abdulali, of the Bombay Natural History Society; and to Mr. P. E. P. Deraniyagala, of the National Museums of Ceylon.

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Acknowledgment for a special kind of helpfulness is made to Mr. Herbert G. Deignan, Curator of Birds, United States National Museum, for a great deal of advice and help in the finding and spelling of place names in Thailand.

Mr. Melvin A. Traylor, Chicago Natural History Museum, provided me with data on the collection localities of Floyd T. Smith in Szechwan, China. Dr. Charles Vaurie, American Museum of Natural History, welcomed us to study his personal set of 1:1 million topographic maps of the Orient.

The skull drawings are from the pen of Mrs. Richard G. Zweifel. The inking and lettering of fourteen of the maps are some of the last work of Mrs. D. F. Levett Bradley, who passed away before completing the series. The maps showing the distribution of *Sciurotamias* and of *Ratufa macroura*, *R. indica*, and of the several species of *Callosciurus* were inked and lettered by Mrs. Zweifel.

## SCOPE

The number of tribes of diurnal squirrels represented in the Oriental Region (5) exceeds that of any other faunal region of the world. The number of genera of diurnal squirrels native to the Oriental Region (17) greatly exceeds that of other faunal regions (see Table 1). Several of the genera listed in Table 1 as Oriental occupy areas marginal to the Oriental Region proper. *Prosciurillus*, *Rubrisciurus*, and *Hyosciurus* are endemic to the island of Celebes, which lies in an area transitional between the Oriental Region and the Australian Region. *Sciurotamias* occupies an area of China which is almost entirely transitional between the Oriental and Palearctic regions. Nevertheless, none of the 17 genera here listed as Oriental extends more than marginally into another of the faunal regions of the world. These data suggest that the Oriental fauna of diurnal squirrels may be the most important in the world to study. They are also a convenient unit to revise.

The Oriental Region is sometimes divided into three subregions: the Indian, the Indochinese, and the Malaysian. In the opinions of some authorities the Philippine Islands constitute a fourth Oriental subregion, but others consider it transitional between the Oriental and Australian regions. The diurnal squirrel fauna of the Oriental Region is well divided by the subregional boundaries. One of us has discussed in detail how the boundary between the Indian and Indochinese subregions separates the giant squirrels as species and all other diurnal squirrels as tribes (Moore, 1960). The boundary between the Indochinese and Malaysian subregions provides a weaker but still very strong division. This boundary is generally (and here) drawn at the constriction of the Malay Peninsula called the Isthmus of Kra. (See the discussion by Chasen, 1940, p. x, and the map, fig. 13 in the present paper.) Figures 7 and 8 combined may be said to indicate crudely the extent of the Indian Subregion by distribution of the squirrels. Figure 13 does the same for the Indochinese Subregion. The scope of the present paper is revision of the Sciurinae of the Indian and Indochinese subregions. A large part of it constitutes the first revision of the species of *Callosciurus* of the Indochinese Subregion.

The gliding squirrels, Petauristinae, which with the Sciurinae constitute the family Sciuridae, are nocturnal and thus more difficult for mammal collectors to obtain. They are rarely collected by ornithologists. Consequently, in American collections of Oriental squirrels, specimens of Petauristinae number about one to every 15 of

Sciurinae. The Petauristinae, although included in the original plans and draft by Tate, have not yet been studied by Moore, but see McKenna (1963).

The geographic area included in the present study is thus precisely that part of the Oriental Region included by Ellerman and Morrison-Scott (1951). For this reason the report here on the giant squirrel species, *Ratufa bicolor*, is confined to the area north of the Isthmus of Kra, although the species range extends southeastward through Malaya, Sumatra, Java, and Bali. There are, however, five other polytypic species with ranges that are widespread in the Indochinese Subregion but that extend beyond its border down the Malay Peninsula for varying distances. These five species are treated in full because their ranges do not extend beyond the length of the peninsula, and because they generally have but one subspecies south of the Isthmus of Kra.

Four-fifths of the species of the genus *Dremomys* are widespread, polytypic species of the Indochinese Subregion. There is, however, a poorly known, apparently monotypic species, *everetti*, confined to Borneo. In the interest of having the revision of the genus *Dremomys* in one publication, a treatment of *everetti* is included here. The forms from south of the Isthmus of Kra that are treated in the present work are labeled "extraterritorial."

## MATERIAL

In the lists of material examined for each form, the locality near which a specimen was taken is ordinarily given as written by the collector on the specimen label. This rule has been departed from occasionally when evidence clearly shows that the collector was spelling the name of one locality in different ways. Since for some Oriental countries one may find the name of a single locality spelled (transliterated to English or French) several different ways on as many maps (e.g., Pak Jong, Pak Chong, Pak Xong), the locality as spelled by the collector may be followed in brackets by the name one of us found on a map and presumed to be the locality meant. Often the collector has recorded on the specimen tag two or more locality names, indicating a village, the town to which it is nearest, and perhaps the provincial capital to which they are both near. If it has not been possible to locate the village on a map, the town or occasionally even the provincial capital has sometimes been plotted as the locality for this specimen on the appropriate species distribu-

TABLE 1. Genera of Sciurinae Characteristic of the Faunal Regions of the World  
 ("T" indicates Indian Subregion; "C" IndoChinese Subregion; "M" Malaysian Subregion).

TRIBES	ETHIOPIAN	ORIENTAL	PALEARCTIC	NEARCTIC	NEOTROPICAL
Ratufini					
Protoxerini	<i>Protoxerus</i> <i>Epixerus</i>	<i>Ratufa</i> (ICM)			
Funambulini	<i>Heliosciurus</i> <i>Funisciurus</i> <i>Paraxerus</i> <i>Myosciurus</i>	<i>Funambulus</i> (I)			
Callosciurini		<i>Callosciurus</i> (CM) <i>Tamias</i> (C) <i>Sundasciurus</i> (M) <i>Dremomys</i> (CM) <i>Lariscus</i> (M) <i>Menetes</i> (C) <i>Nannosciurus</i> (M) <i>Glyphotes</i> (M) <i>Rhinosciurus</i> (M) <i>Erethisciurus</i> (M) <i>Prosciurillus</i> (M) <i>Rubrisciurus</i> (M) <i>Hyosciurus</i> (M) <i>Reithrosciurus</i> (M)			
Sciurini			<i>Sciurus</i>	<i>Sciurus</i>	<i>Guerlinguetus</i> <i>Microsciurus</i> <i>Syntheosciurus</i> <i>Sciurillus</i>
Marmotini			<i>Marmota</i> <i>Spermophilus</i>	<i>Marmota</i> <i>Spermophilus</i> <i>Ammospermophilus</i> <i>Cynomys</i> <i>Tamias</i> <i>Eutamias</i> <i>Tamiasciurus</i>	
Tamiasciurini		<i>Sciurotamias</i> (C)	<i>Eutamias</i> <i>Sciurotamias</i> <i>Atlantoxerus</i> <i>Spermophilopsis</i>		
Xerini	<i>Xerus</i>				
Totals:	3	5	4	3	1
Tribes	7	17	7	8	4
Genera					



tion map. The instances in which this has been done are clearly indicated as follows: the localities not found (as well as any others, such as "India," not suitable for plotting) are placed in quotation marks in the list of material examined, and the nearby places that are plotted instead are italicized (e.g., the village, subdistrict town, district town, and provincial capital "Ban Maeo, Goksatawn," *Dan Sai*, Loei, Thailand).

In our lists of material examined, the institutions in which the study material is housed are cited by initials as follows:

- AMNH—American Museum of Natural History, New York
- ANSP—Academy of Natural Sciences, Philadelphia
- ASB—Asiatic Society of Bengal, Calcutta
- BM—British Museum (Natural History), London
- CBK—Private collection of C. Boden Kloss (not seen)
- CNHM—Chicago Natural History Museum, Chicago
- IM—Indian Museum, Calcutta
- MCZ—Museum of Comparative Zoology, Cambridge, Massachusetts
- MNCN—Museo Nacional de Ciencias Naturales, Madrid
- MNHN—Museum National d'Histoire Naturelle, Paris
- MNHUI—Museum of Natural History, University of Illinois, Urbana
- NM—Naturhistorisches Museum, Basel
- NMC—National Museums of Ceylon, Colombo
- NR—Naturhistoriska Riksmuseum, Stockholm
- RNH—Rijksmuseum van Natuurlijke Historie, Leiden
- SMT—Staatliches Museum für Tierkunde, Dresden
- SNG—Senckenbergisches Naturforschende Gesellschaft, Frankfurt-am-Main
- UMMZ—University of Michigan Museum of Zoology, Ann Arbor
- UZM—Universitetets Zoologiske Museum, Oslo
- ZI—Zoologiska Institutionen, Uppsala
- ZMHU—Zoological Museum of Humboldt University, Berlin

## METHODS

In many species the present work has been based on remarkably fine and extensive collections. Some mainland subspecies are known from at least one large series of specimens from a single locality, and smaller numbers from a dozen other widely distributed localities, providing, thus, some indication of individual variation with which to evaluate evidence of geographic variation. Other subspecies are represented by much less material, and future collections may enable other students to define better the characteristics and ranges of many subspecies. In order to facilitate advancement of knowledge of these species, we have attempted to present our knowledge in detail specific enough to enable future students to add their evidence to ours, perhaps without the necessity of restudy of the pertinent material on which we report.

*Color.*—One of us (Moore) has employed Ridgway's (1912) nomenclature, and where capitalized color names are used in this paper, direct comparison of the pelage(s) with Ridgway's colors is implied. To determine color of a series of study skins, we arranged them on a horizontal plane before a window, preferably at a time between 10 A.M. and 4 P.M. and when the sky was blue, but never when the sun could shine directly on the specimens. The skins were oriented with tails toward the window, and the color comparison was made from a view perpendicular to the surface upon which the specimens lay, and thus from a point directly above the part being compared.

Color comparisons were virtually all made at the institution in which the study specimens were stored, but at the United States National Museum, because of cloudy weather and distance to windows, some color readings were taken under direct light of an ordinary 100-watt, electric light bulb with a tungsten filament.

In order to avoid the risk of losing or damaging a copy of Ridgway by traveling with it, we borrowed and used different copies at the different institutions. Comparisons of material at one museum with material at another by Ridgway color names risks variation between copies of the book, and is thus relatively seldom employed here. Persons seeking to make identifications of considerable importance are advised in no case to depend solely upon distinguishing a small difference in colors in Ridgway (1912), but to send skins and skulls to one of the museums listed as having materials of the presumed form for confirmation of the identification. It should perhaps be pointed out that diagnosis of a subspecies of Oriental diurnal squirrel rarely depends upon color of a single part of the pelage which is only one Ridgway color chip different from an adjacent subspecies.

The term "agouti" as used here means body pelage with one or more minute contrasting color bands on the individual hairs that, in a broad view of the pelage, produce a speckled effect. Except where otherwise stated, color of agouti pelage is recorded here as the general effect of the visible portions of the pelage, its contrasted elements blended by viewing without magnification with the viewer's eyes deliberately out of focus. The banding of agouti body pelage generally consists of one, two or three light-colored bands (parts of the length of a hair sharply differentiated by color) on any particular hair, but some hairs in agouti pelage have no bands at all. On the individual hairs of the tail, it is the black or blackish bands that are counted unless specifically otherwise stated, and the count of blackish bands on individual hairs does not include the almost ubiquitously

black tip because this tip is often markedly thinner than the remainder of the hair, and often shorter than the blackish bands.

*Form of presentation.*—Decision to change the study of the Oriental squirrels from a review to a revision derived in part from a growing curiosity about the origins of the species and from discovery of indications that better study would reveal firmer evidence on the manner of their evolution. In the Indochinese Subregion, for example, the exceedingly rich and rather well-collected diurnal squirrel fauna has been evolving on an orogenically and tectonically active mainland that has been sliced into parallel north-south strips of land by large rivers that flow down from the Tibetan Plateau.

Thus the intention has not been primarily the laudable desire to bring badly needed order to a chaotic fauna and to complete a convenient revision by means of which virtually all new specimens might be identified to subspecies. The emphasis has rather been to revise the species for evidence about the evolution of the species from coincidence of morphological and geographic relationships. Where the relationships have been obvious enough from the material examined, there has been some tendency simply to plot the subspecies distribution on the map, record the material examined, and move on: Where differences have been more difficult to see, as in the subspecies of *pygerythrus* or the relationships of *phayrei*, elaborate written analyses became necessary and have, of course, been incorporated into the revision. New evidence on relationships between species has been especially sought, and where found is given in detail.

To synonymize subspecies without explanation is certainly not a policy which we would wish to advocate. Generally, where there has seemed to be basis enough for a finer splitter to recognize a subspecies that we have lumped with another, we have pointed that out. But the 6½ years spent has been too short, the digressions to exploit important discoveries too long, and the pressure from supporters to complete a revisionary manuscript too great, to allow the explanation of why each named form that we have synonymized is by our observations undeserving of recognition.

*Size and dimensions.*—Students who have studied species that are more conservative in pelage color and more variable in skull dimensions than diurnal tree squirrels may be surprised at how seldom we have needed to utilize measurements. Tree squirrels are, however, well known to be especially conservative in variation in dimensions of the skull. (See Moore, 1959, p. 192 and Table 3.) On hearing that the discovery of a skull character that seemed to



sort tree squirrels into tribes was tempting us to digress, one senior mammalogist assured us almost bitterly, "If you discover one good skull character in tree squirrels, it will be worth every dollar the foundation puts into your project." A number of good skull characters at the generic level and above were discovered and reported (Moore, 1959), but at the species and subspecies level in tree squirrels it has been obvious that the return for effort expended would be impractical for a revision so extensive. In the semi-terrestrial long-nosed squirrels, however, species differences in skulls could be detected and are utilized.

Scientists who have presented, and to an extent utilized, body and skull dimensions in their revisions of much smaller taxonomic units may find it difficult to endure our failure to emulate their admirable intensive methods in our work. Tate obtained and recorded body and skull measurements and other data for each type specimen. Those of the body he apparently copied from specimen tags, adding plus-or-minus to measurements whose accuracy he doubted. He measured the skulls himself. Some of these data for each genus are presented in Tables 2-4, 6, 8-13, and 15. In these tables total length of skull is the greatest occipitonasal length. Mastoid breadth is the greatest span of the mastoid processes. Nasal length is the greatest length of the longer nasal bone. Diastema is the least distance from the alveolus of the incisor to the alveolus of the fourth upper premolar. Length of palate is the distance from the gnathion to the most anterior point on the posterior margin of the palate. Length of bulla is the greatest external length of the auditory bulla. Maxillary toothrow is the crown length of the upper row of cheekteeth from the most anterior extension of the crown of the fourth premolar to the most posterior point on the crown of the third molar. Orbitonasal length (used in fig. 28) is taken from the most anterior point in the margin of the right orbit to the most anterior point on the right nasal. Length of orbit (used in fig. 29) is taken from the most anterior point on the margin of the orbit (a small notch in the posterior margin of the lacrimal) to the most posterior point on the margin of the orbito-temporal fossa.

*Order.*—The order of genera progresses from those with no transverse septum in the auditory bulla to three such septa, as in the latest classification of the Sciurinae (Moore, 1959). This progression is considered to be from unspecialized to rather highly specialized in this particular character, but it does not imply that *Ratufa* is unspecialized in general adaptation to a niche (which would be untrue) or



that *Sciurotamias* is highly specialized in general adaptation to a niche (though this may be true). The order of species within a genus, and subspecies within a species, is geographical, from a convenient edge of the range toward the far edges.

Under accounts of the genera we give the accepted name, synonyms if any, type species, definition, and diagnosis. Where it has seemed especially valuable, we have included data on systematic history and intra-generic relationships, and in several instances have provided keys to identification of the species.

In the account of each polytypic species we have given the accepted name, definition, and diagnosis. If it belongs in a polytypic genus we have generally commented on its relationships to other congeneric species with which it is in geographic contact, or which it particularly resembles. Sometimes the species account has seemed the proper place for general comments on the intraspecific variation. In a few instances a systematic history of the species is provided, and in the case of the extraterritorial species *Dremomys everetti* observation of the rarely seen deciduous upper third premolars stimulated some further investigation and reporting of aspects not treated here in the other species.

In each account of subspecies and monotypic species, we have given the accepted name, synonyms if any, information on the type specimen(s), and a list of the material examined. If some information regarding the type is lacking from our account, this may be taken to imply that we did not find that information with the original materials examined or in the original published account. If our data and observations and opinions on a type (generally Tate's, of course) differ from any given in the original published description of the form, this may be assumed to mean that our information, observation, or opinion (recorded by Tate) differs from that of the original describer. The list of material examined is generally followed by one or more descriptions. These descriptions may be of three kinds, and the kind is indicated by the heading given to each. "Original Description" designates a quotation from the original published description, usually of the type specimen, of course. "Type Description" designates observations by one of us of the type specimen or the cotypes. Unless dated after 1953, these are Tate's observations, expanded from his telegraphic notes. "Pelage Color" designates descriptions from series of specimens considered to represent populations constituting the subspecies under consideration. These are given in Ridgway's color terms, and the observations were

made in the manner described above in the account of color. Discussion of some especially interesting or significant features is sometimes contributed under the heading "Variation," "Dimensions," or "Discussion," and field observations from the literature are occasionally quoted under the heading "Habits." When only one small paragraph of comment follows the list of material examined, no heading is applied to it.

### TAXONOMIC HISTORY

Because the Sciurinae are active by day and often brilliantly colored, they have long claimed the interest of naturalists. In the Oriental Region, Horsfield (1824) was one of the earliest to attempt to summarize knowledge of the squirrels. In his "General enumeration of Indian Sciuri" he listed twelve species of non-flying squirrels under the generic name *Sciurus*, including representatives of the modern genera *Callosciurus*, *Lariscus*, *Funambulus*, and *Ratufa*.

Gray (1867) briefly keyed out and roughly classified the Oriental squirrels by simple pelage and tooth characters but he missed what now seem to be the most obvious of relationships and lumped together in one genus, *Macroxus*, some species now considered tribally different. John Anderson (1878, pp. 214-277) in order to identify his collections of squirrels from Burma reviewed all of the known Oriental squirrels. His conservatism in admitting *Reithrosciurus* and *Rhinosciurus* only to subgeneric rank seems a matter of the custom of his time, but the superficiality of his observations on the diagnostic characteristics of their skulls contrasts sharply with his penetrating observations on pelage color of squirrels in the Indochinese Subregion and his shrewd speculations as to the relationships that these indicate.

Trouessart (1880) correctly recognized, as Gray (1867) had not, that the forms *bicolor*, *giganteus*, *indicus*, *maximus*, and *macrurus* belonged together in a taxon at least subgenerically distinct from typical *Sciurus*. He recognized *Funambulus* as of subgeneric value, but placed in it virtually every named Indochinese squirrel with stripes, including *berdmorei*, *mcclellandi*, and even *quinquestriatus*. In an Asiatic and Malaysian subgenus he also proposed to include *erythraeus* and *lokroides* with *lokriah*, *pernyi*, and *rufigenus*, among others, and included  *davidianus* in the subgenus *Rhinosciurus* with *laticaudatus*.

Jentink (1883) recognized as belonging in the genus *Sciurus* the species *erythraeus*, *lokroides*, *caniceps*, *atrodorsalis*, *quinquestriatus*,

*castaneoventris*, and *pygerythrus* from this region, but he included in the same genus the species *lokriah* and *pernyi* (now in *Dremomys*) and  *davidianus* and *berdmorei* (now respectively in *Sciurotamias* and *Menetes*) and three species now properly belonging to *Funambulus*. For the two subregions under discussion he admitted but one genus of diurnal squirrels and no subgenera. By grouping, however, he recognized affinities among species now known to belong to the genera *Ratufa*, *Funambulus*, and *Dremomys*.

Blanford's (1888-91) taxonomic treatment of the squirrels of these two subregions differs little from Jentink's, but Blanford provided keys and more detailed characterizations.

Major (1893, p. 189), using primarily characters of the teeth and to a lesser extent those of the skull, produced a classification of the living Sciuridae with six genera in the Sciurinae. One of the largest is *Xerus*, composed of five subgenera, four of which are entirely African tree and ground squirrels. The fifth subgenus was *Eoxerus*, and in it were the two commonest species of the Indian Subregion, *palmarum* and *pennanti*, now included in *Funambulus*, *berdmorei*, now included in *Menetes*, and three Malaysian ground squirrel species of the present genus *Lariscus*. Under the genus *Sciurus*, subgenus *Sciurus*, and beta group he included tree squirrels of the Indochinese Subregion—*erythraeus*, *atrodorsalis*, *caniceps*, *ferrugineus*, and *lokroides*—and several tree squirrels of the Malaysian Subregion as well as one long-nosed species, *everetti*. Major ends this list with "etc.," which probably implies that long-nosed species *rufigenus*, *pernyi*, and *lokriah* belong here, too. He holds to genus *Sciurus*, subgenus *Eosciurus*, for the several Oriental giant squirrel species as proposed by Trouessart.

Thomas (1915) separated Indochinese and Malaysian tree squirrel species from the genus *Sciurus*, noting that they are distinguished by the presence of a separate bony blade associated with the shaft of the os penis. These tree squirrels of the Indochinese Subregion (and Malaysian Subregion) he recognized as *Callosciurus* and *Tomeutes*.

Robinson and Kloss (1918) contributed a valuable list of the Sciuridae of the Oriental Region. They admitted nine species of *Ratufa*. In the Indochinese Subregion they admitted 15 species in what is now accepted as *Callosciurus*.

Pocock (1923) followed Thomas' lead with a classification of the Sciuridae based upon further extensive study of the baculum (os penis) and glans penis. He associated the Indian striped squirrels, *Funambulus*, and Oriental giant squirrels, *Ratufa*, with several genera



of tree squirrels of the Ethiopian Region in one subfamily, but placed other Oriental squirrels (excluding *Reithrosciurus*) in a strictly Oriental subfamily, Callosciurinae. Simpson (1945) accepted Pocock's classification but scaled his subfamilies down to tribes. Moore (1959) found new skull characters which generally support Pocock's classification as modified by Simpson, and by which one may allocate several Oriental genera, the bacula of which are still unknown, to the tribe Callosciurini.

Ellerman (1940) offered an arrangement of the species and subspecies of Oriental squirrels, and Ellerman and Morrison-Scott (1951) offered an arrangement of species and subspecies of Sciurinae of the Indian and Indochinese subregions. These are checklists and not revisions at the species and subspecies level, and although there are many taxonomic decisions implicit in their arrangement, based on study of specimens, the evidence for these is not given.

Zahn (1942) offered a revision of the genera, species, and subspecies of the giant squirrels, striped squirrels, and long-nosed squirrels of the Oriental Region, based on study of material in European museums.

Other authors have published many helpful papers revising small groups of diurnal squirrels of this region. Some of these will be mentioned in the following species accounts. Some authors have provided important revisions of the Sciurinae included in large faunal papers. Of the latter the papers of G. M. Allen (1940) and Osgood (1934) are particularly helpful.

#### CLASSIFICATION

The classification presented here constitutes conclusions derived from the whole present work and might with logic be placed at the end of the work. However, the choice had to be made between logic of presentation and convenience of use. We hope that some students will, indeed, weigh our logic, but we presume, however wrongly, that most students turning these pages, will be primarily interested in using our results. The attained classification is therefore provided in the introduction where it can serve conveniently as a framework for apprehending the work as a whole or the relationships of some particular genus or species.

One of us (Moore, 1959) has reported in detail the tribal level skull characters that distinguish the following genera from all others in the Oriental Region: *Ratufa* (op. cit., p. 169), *Funambulus* (p. 170),

and *Sciurotamias* (p. 182). The other existing genera of the Sciurinae of the Indochinese Subregion may be identified in the key to the genera and subgenera of the subtribe Callosciurina (op. cit., pp. 173-174). *Tamiops* is treated as a subgenus in that key.

CLASSIFICATION OF THE SCIURINAE OF THE INDIAN AND  
INDOCHINESE SUBREGIONS

Tribe Ratufini Moore, 1959. Oriental Region.

Genus *Ratufa* Gray, 1867. Oriental Region.

Species *macroura* Pennant, 1769. Ceylon and tip of Indian Peninsula.

Subspecies *macroura* Pennant, 1769 (including:

*ceylonicus* Erxleben, 1777.

*ceylonensis* Boddaert, 1785.

*tennenti* Blyth, 1849.

*montanus* Kelaart, 1852.

*macrurus* Blanford, 1891.)

*melanochra* Thomas and Wroughton, 1915.

*dandolena* Thomas and Wroughton, 1915 (including  
*sinhala* Phillips, 1931.)

Species *indica* Erxleben, 1777. Indian Subregion.

Subspecies *dealbata* Blanford, 1897.

*indica* Erxleben 1777 (including:

*purpureus* Zimmerman, 1777.

*bombayus* Boddaert, 1785.

*elphinstonei* Sykes, 1831.

*superans* Ryley, 1913.)

*maxima* Schreber, 1784 (including:

*malabaricus* Scopoli, 1786.

*bengalensis* Blanford, 1897.)

*centralis* Ryley, 1913.

Species *bicolor* Sparrmann, 1778. Indochinese and Malaysian Subregions.

Subspecies *phaeocephala* Miller, 1913 (including:

*celaenopepla* Miller, 1913.

*marana* Thomas and Wroughton, 1924.)

*leucogenys* Kloss, 1916.

*sinus* Kloss, 1916 (not mapped).

*smithi* Robinson and Kloss, 1922.

*condorensis* Kloss, 1920 (not mapped).

*felli* Thomas and Wroughton, 1916.

*gigantea* McClelland, 1839 (including:

*macruroides* Hodgson, 1849.

*lutrina* Thomas and Wroughton, 1916.)

*hainana* J. A. Allen, 1906 (including

*stigmosa* Thomas, 1923.)

Tribe Funambulini Simpson, 1945. Ethiopian and Oriental Regions.

Subtribe Funambulina Moore, 1959. Indian Subregion.

Genus *Funambulus* Lesson, 1832. Indian Subregion.

Subgenus *Prasadscurus*, new subgenus

Species *pennanti* Wroughton, 1905. Northern India, W. Pakistan, Nepal.

Subspecies *pennanti* Wroughton, 1905.

*lutescens* Wroughton, 1916.

*argentescens* Wroughton, 1905.

Species *palmarum* Linnaeus, 1766. Central and southern India and Ceylon.

Subspecies *palmarum* Linnaeus, 1766 (includes:

*penicillatus* Leach, 1814.

*indicus* Lesson, 1835.

*gossei* Wroughton and Davidson, 1919.)

*comorinus* Wroughton, 1905.

*bellarius* Wroughton, 1916.

*robertsoni* Wroughton, 1916.

*bengalensis* Wroughton, 1916.

*favonicus* Lindsay, 1926.

*kelaarti* Blyth, 1851.

*brodiei* Blyth, 1849.

*olympius* Thomas and Wroughton, 1915.

Species *tristriatus* Waterhouse, 1837. Western Ghats.

Subspecies *tristriatus* Waterhouse, 1837 (including:

*dussumieri* Milne-Edwards, 1867.

*annandalei* Robinson, 1917.)

*wroughtoni* Ryley, 1913.

*numarius* Wroughton, 1916 (including

*thomasi* Wroughton and Davidson, 1919.)

Species *layardi* Blyth, 1849. Ceylon and southern India.

Subspecies *layardi* Blyth, 1849.

*signatus* Thomas, 1924.

*dravidianus* Robinson, 1917.

Species *sublineatus* Waterhouse, 1838. Ceylon and southern India.

Subspecies *sublineatus* Waterhouse, 1838 (including:

*delesserti* Gervais, 1841.

*trilineatus* Blyth, 1849.)

*obscurus* Pelzeln and Kohl, 1886 (including

*kathleenae* Thomas and Wroughton, 1915.)

Tribe Callosciurini Simpson, 1945. Indochinese and Malaysian Subregions.

Subtribe Callosciurina Moore, 1959. Indochinese and Malaysian Subregions.

Genus *Callosciurus* Gray, 1867. Indochinese and Malaysian Subregions.

Species *erythraeus* Pallas, 1778. Indochinese Subregion west of Irrawaddy River.

Subspecies *erythraeus* Pallas 1778 (including

*wellsi* Wroughton, 1921.)

*erythrogaster* Blyth, 1842 (including:

*punctatissimus* Gray, 1867.

*nagarum* Thomas and Wroughton, 1916.

*kinneari* Thomas and Wroughton, 1916.

*crotalius* Thomas and Wroughton, 1916.)

*bhutanensis* Bonhote, 1901 (including

*crumpi* Wroughton, 1916.)

*intermedius* Anderson, 1879 (including

*aquilo* Wroughton, 1921.)

*sladeni* Anderson, 1871 (including:

*kemmisi* Wroughton, 1908.

*rubex* Thomas, 1914.

*midas* Thomas, 1914.

*vernayi* Carter, 1942.)

*bartoni* Thomas, 1914 (including:

*shortridgei* Thomas and Wroughton, 1916.

*fryanus* Thomas and Wroughton, 1916.

*millardi* Thomas and Wroughton, 1916.

*caryi* Thomas and Wroughton, 1916.)  
*haringtoni* Thomas, 1905 (including  
*solutus* Thomas, 1914.)

Species *flavimanus* I. Geoffroy, 1831. Indochinese Subregion east of Irrawaddy.

Subspecies *quinquestriatus* Anderson, 1871 (including:

*beebei* J. A. Allen, 1911.  
*imarius* Thomas, 1926.  
*sylvester* Thomas, 1926.)  
*gordoni* Anderson, 1871.  
*shanicus* Ryley, 1914 (including  
*?griseopectus* Blyth, 1847.)  
*hyperythrus* Blyth, 1855. (not mapped, no localities)  
*michianus* Robinson and Wroughton, 1911 (including  
*haemobaphes* G. M. Allen, 1912.)  
*zimmeensis* Robinson and Wroughton, 1916 (including  
*primus* Allen and Coolidge, 1940.)  
*thai* Kloss, 1917.  
*atrodorsalis* Gray, 1842.  
*siamensis* Gray, 1860 (including  
*tachin* Kloss, 1916.)  
*pranis* Kloss, 1916.  
*rubeculus* Miller, 1903 (including  
*youngi* Robinson and Kloss, 1914. Unmapped. Extrateritorial.)  
*hendeei* Osgood, 1932.  
*castaneiventris* Gray, 1842 (including  
*insularis* J. A. Allen, 1906.)  
*flavimanus* Geoffroy St. Hillaire, 1831 (including:  
*quantulus* Thomas, 1927.  
*contumax* Thomas, 1927.  
*dactylinus* Thomas, 1927.  
*pirata* Thomas, 1929.  
*bolovens* Osgood, 1932.)  
*griseimanus* Milne-Edwards, 1867 (including:  
*leucopus* Gray, 1867.  
*fumigatus* Bonhote, 1907.  
*vassali* Bonhote, 1907.  
*phanrangis* Robinson and Kloss, 1922.)  
*gloveri* Thomas, 1921.  
*bonhotei* Robinson and Wroughton, 1911.  
*styani* Thomas, 1894 (including:  
*griseopectus* Milne-Edwards, 1874.  
*Herpestes* [sic] *leucurus* Hilzheimer, 1905.  
*Herpestes* [sic] *albifer* Hilzheimer, 1906.  
*canigenus* Howell, 1927.  
*woodi* Harris, 1931.)  
*ningpoensis* Bonhote, 1901 (including  
*tsingtanensis* Hilzheimer, 1905.)  
*thaiwanensis* Bonhote, 1901 (including:  
*centralis* Bonhote, 1901.  
*roberti* Bonhote, 1901.  
*nigridorsalis* Kuroda, 1935.)

Species *ferrugineus* F. Cuvier, 1829. Indochinese Subregion east of Irrawaddy (including *keraudreni* Lesson, 1830.)

Species *finlaysoni* Horsfield, 1824. Indochinese Subregion east of Salween River.

- Subspecies *finlaysoni* Horsfield, 1824 (including  
*portus* Kloss, 1915.)  
*folletti* Kloss, 1915.  
*trotteri* Kloss, 1916.  
*frandseni* Kloss, 1916.  
*albivexilli* Kloss, 1916.  
*harmandi* Milne-Edwards, 1876 (including  
*pierrei* Robinson and Kloss, 1922.)  
*germaini* Milne-Edwards, 1867.  
*nox* Wroughton, 1908.  
*cinnamomeus* Temminck, 1853 (including:  
*splendens* Gray, 1861.  
*herberti* Robinson and Kloss, 1922.)  
*annellatus* Thomas, 1929.  
*williamsoni* Robinson and Kloss, 1922.  
*menamicus* Thomas, 1929 (1928).  
*sinistralis* Wroughton, 1908 (including:  
*dextralis* Wroughton, 1908.  
*lylei* Wroughton, 1908.  
*grutei* Gyldenstolpe, 1917.)  
*boucourti* Milne-Edwards, 1867 (including:  
*leucogaster* Milne-Edwards, 1867.  
*leucocephalus* Bonhote, 1901.  
*floweri* Bonhote, 1901.  
*tachardi* Robinson, 1916.  
*prachin* Kloss, 1920.  
*rajasima* Kloss, 1920.  
*cockerelli* Thomas, 1928.)  
*boonsongi*, new subspecies.

Species *caniceps* Gray, 1842. Indochinese Subregion west of Mekong River.

- Subspecies *concolor* Blyth, 1855 (including:  
*lancavensis* Miller, 1903.  
*erubescens* Cabrera, 1917.  
*telibius* Thomas and Robinson, 1921 Extraterritorial.)  
*adangensis* Miller, 1903 (including:  
*terutavensis* Thomas and Wroughton, 1909.  
*moheius* Thomas and Robinson, 1921.  
*mohillius* Thomas and Robinson, 1921.)  
*bimaculatus* Temminck, 1853 (including:  
*epomophorus* Bonhote, 1901.  
*davisoni* Bonhote, 1901.  
*sullivanus* Miller, 1903.  
*matthaeus* Miller, 1903.  
*lucas* Miller, 1903.  
*milleri* Robinson and Wroughton, 1911.  
*samiensis* Robinson and Kloss, 1914.  
*nakanus* Thomas and Robinson, 1921.  
*mapravis* Thomas and Robinson, 1921.  
*panjius* Thomas and Robinson, 1921.  
*panjioli* Thomas and Robinson, 1921.  
*tacopijs* Thomas and Robinson, 1921.  
*pipidonis* Thomas and Robinson, 1921.  
*tabaudius* Thomas, 1922.  
*hastilis* Thomas, 1923.)



- casensis* Miller, 1903 (unmapped).
- fallax* Robinson and Kloss, 1914 (unmapped).
- domelicus* Miller, 1903 (including  
    *bentincanus* Miller, 1903.)
- caniceps* Gray, 1842 (including:  
    *chrysonotus* Blyth, 1847.  
    *inexpectatus* Kloss, 1916.  
    *helgei* Gyldenstolpe, 1917.  
    *helvus* Shamel, 1930.)

Species *phayrei* Blyth, 1855. Indochinese Subregion west of Salween (including: *blanfordi* Blyth, 1862, and *heinrichi* Tate, 1954.)

Species *inornatus* Gray, 1867. Indochinese Subregion east of Mekong (including *imitator* Thomas, 1925.)

Species *pygerythrus* Geoffroy St. Hillaire, 1832. Indochinese Subregion west of Irrawaddy.

Subspecies *pygerythrus* Geoffroy St. Hillaire, 1832.

- janetta* Thomas, 1914.
- owensi* Thomas and Wroughton, 1916.
- mearsi* Bonhote, 1906 (including:  
    *bellona* Thomas and Wroughton, 1916.  
    *virgo* Thomas and Wroughton, 1916.)
- stevensi* Thomas, 1908.
- blythi* Tytler, 1854.
- lokroides* Hodgson, 1836 (including:  
    *assamensis* Gray, 1843.  
    *similis* Gray, 1867.)

Genus *Tamiops* Allen, 1901. Indochinese Subregion and Malaya.

Species *maclellandi* Horsfield, 1839. Indochinese Subregion and extraterritorial subspecies in Malaya.

Subspecies *maclellandi* Horsfield, 1839 (including:

- pembertoni* Blyth, 1842.
- manipurensis* Bonhote, 1900.)
- collinus* Moore, 1958.
- inconstans* Thomas, 1920.
- kongensis* Bonhote, 1901.
- barbei* Blyth, 1847.
- leucotis* Temminck, 1853 (including  
    *novemlineatus* Miller, 1903.)

Species *rodolphei* Milne-Edwards, 1867. Thailand, Laos, Cambodia.

Subspecies *rodolphei* Milne-Edwards, 1867 (including:

- liantis* Kloss, 1919.
- lylei* Thomas, 1920.
- dolphoides* Kloss, 1922.
- holti* Ellerman, 1940.)
- elbeli* Moore, 1958.

Species *swinhoei* Milne-Edwards, 1874. Yunnan, Szechwan, Burma.

Subspecies *swinhoei* Milne-Edwards, 1874 (including:

- clarkei* Thomas, 1920.
- forresti* Thomas, 1920.
- spencei* Thomas, 1921.
- russeolus* Jacobi, 1923.
- olivaceus* Osgood, 1932.)
- vestitus* Miller, 1915.

Species *maritimus* Bonhote, 1900. Southern China, Vietnam.

- Subspecies *maritimus* Bonhote, 1900 (including:  
*formosanus* Bonhote, 1900.  
*sauteri* J. A. Allen, 1911.)  
*monticolus* Bonhote, 1900.  
*hainanus* J. A. Allen, 1906 (including:  
*riudoni* J. A. Allen, 1906.  
*laotum* Robinson and Kloss, 1922.)  
*moi* Robinson and Kloss, 1922.
- Genus *Dremomys* Heude, 1898. Indochinese and Malaysian Subregions.
- Species *lokriah* Hodgson, 1836. Nepal, Assam, northern Burma.
- Subspecies *lokriah* Hodgson, 1836 (including:  
*bhotia* Wroughton, 1916.  
*subflaviventris* Thomas, 1922.)  
*garonum* Thomas, 1922.  
*pagus* Moore, 1956.  
*macmillani* Thomas and Wroughton, 1916.
- Species *pernyi* Milne-Edwards, 1867. Assam to Chekiang above Tropic of Cancer.
- Subspecies *pernyi* Milne-Edwards, 1867 (including:  
*griselda* Thomas, 1916.  
*lichiensis* Thomas, 1922.  
*lentus* A. B. Howell, 1927.)  
*howelli* Thomas, 1922 (including:  
*mentosus* Thomas, 1922.  
*imus* Thomas, 1922.)  
*flavior* G. M. Allen, 1912.  
*senex* G. M. Allen, 1912 (including  
*modestus* Thomas, 1916.)  
*calidior* Thomas, 1916 (including  
*chintalis* Thomas, 1916.)  
*owstoni* Thomas, 1908.
- Species *rufigenus* Blanford, 1878. Indochinese Subregion and Malaya.
- Subspecies *rufigenis* Blanford, 1878 (including:  
*fuscus* Bonhote, 1907.  
*adamsoni* Thomas, 1914.  
*ornatus* Thomas, 1914.  
*laomache* Thomas, 1921.  
*belfieldi* Bonhote, 1908.  
*opimus* Thomas and Wroughton, 1916.
- Species *pyrrhomerus* Thomas, 1895. Southern China, northern Vietnam.
- Subspecies *pyrrhomerus* Thomas, 1895.  
*riudonensis* J. A. Allen, 1906 (including  
*melli* Matschie, 1922.)  
*gularis* Osgood, 1932.
- Species *everetti* Thomas, 1890. Montane Borneo. (Extraterritorial)
- Genus *Menetes* Thomas, 1908. Indochinese Subregion.
- Species *berdmorei* Blyth, 1849. Indochinese Subregion.
- Subspecies *berdmorei* Blyth, 1849 (including  
*amotus* Miller, 1914.)  
*peninsularis* Kloss, 1919.  
*moerescens* Thomas, 1914.  
*decoratus* Thomas, 1914.  
*consularis* Thomas, 1914.  
*mouhotei* Gray, 1861 (including:  
*pyrrhocephalus* Milne-Edwards, 1867.  
*koratensis* Gyldenstolpe, 1917.)

- Tribe *Tamiasciurini*<sup>1</sup> Simpson, 1945. Nearctic Region and Oriental Region.  
Genus *Sciurotamias* Miller, 1901. Montane China, Sikang to Chekiang.  
Subgenus *Sciurotamias* Miller, 1901. Montane China, Sikang to Chekiang.  
Species  *davidianus* Milne-Edwards, 1867. Montane Sikang to Chekiang, China.  
Subspecies  *davidianus* Milne-Edwards, 1867 (including  
     *latro* Heude, 1898.)  
     *consobrinus* Milne-Edwards, 1868-74 (including:  
         *collaris* Heude, 1898.  
         *saltitans* Heude, 1898.  
         *owstoni* J. A. Allen, 1909.  
         *thayeri* G. M. Allen, 1913.)  
Subgenus  *Rupestes* Thomas, 1922. Montane Yunnan and Sikang, China.  
Species  *forresti* Thomas, 1922. Montane Yunnan and Sikang, China.

<sup>1</sup> While the present paper was in press, Black (1963) published his dissertation on the North American Tertiary Sciuridae (localities in the United States and Mexico; 12 genera, 5 with living species). From that study Black says he proposes classification of the 37 living genera of Sciurinae of the world. However, besides including names of some North American fossil genera, Black (1963, p. 123) proposed only two changes from the most recent previous classification (Moore, 1959, p. 198-200).

One change suggested raising the chipmunk taxon from subtribal to tribal level because . . . "I feel that they differ from the marmots and the spermophiles as greatly as they do from the tree squirrels and are fully entitled to tribal status." No evidence, no discussion of relative merits, only opinion based on study of Nearctic fossils representing two of the eight tribes earlier known. The present writer studied all of the living genera of Sciurinae comparatively and quantitatively, amassed a great deal of evidence, tabulated and discussed this, and concluded that in comparison with the marmots and with all other suprageneric taxa of living sciurines, chipmunks merit subtribal rank (Moore, 1959, pp. 162-166, 180-182). It is recommended that their proposed elevation to tribal rank be rejected.

The other change offered by Black (1963) is dissolution of the generally accepted tribe *Tamiasciurini*. Black (1963, p. 125) reports that 3 of the 26 skulls of *Tamiasciurus* at the Museum of Comparative Zoology have only two transbullar septa per bulla, but he evidently did not read the method for counting these provided in the caption of Table 1 (Moore, 1959, p. 163). There were 3 specimens with only two pairs of septa in 138 specimens at the American Museum of Natural History (Moore, 1959, table 1). If we add these to the 6 that I now find in 361 specimens of *Tamiasciurus* in Chicago Natural History Museum, the total is 9 per 499, or less than two percent. For the record, totals of specimens in the latter two museums for 2, 2½, 3 3½, and 4 pairs of septa are respectively 9, 12, 473, 3, and 1 individuals of *Tamiasciurus*. Black's (1963, p. 125) proposal to reduce the rank of the *Tamiasciurini* seems to be based on too small a sample, faultily observed, for one character (number of transbullar septa), and on an unjustified complaint that the other character (high squamosal) "is extremely hard to evaluate." Consequently, I have retained *Tamiasciurini*.

I placed *Sciurotamias* in the *Tamiasciurini* (Moore, 1959, pp. 182-184) only tentatively, trusting it will stimulate publication of pertinent new observations, and I am keeping it there in the present work.



## GIANT SQUIRRELS

### Genus RATUFA Gray

*Ratufa* Gray, 1867, Ann. Mag. Nat. Hist., (ser. 3), 20, p. 273.

*Rukaia* Gray, 1867, Ann. Mag. Nat. Hist., (ser. 3), 20, p. 275.

*Eosciurus* Trouessart, 1880, Le Naturaliste, 2, no. 37, p. 291.

*Type species*.—*Ratufa*, *Sciurus indicus* Erxleben; *Rukaia*, *Sciurus macrourus* Pennant; and *Eosciurus*, *Sciurus bicolor* Sparrmann.

*Definition*.—The genus *Ratufa* contains only the species *macroura*, *indica*, *bicolor*, and *affinis* and is endemic in the Oriental Region.

*Diagnosis*.—Consult Figure 1 for some of the following details. (1) The squamoso-alisphenoid suture lies about halfway between the third upper molar and the posterior margin of the base of the zygomatic process of the squamosal. (2) The chambers of the auditory bullae are not crossed by transbullar septa. (3) The palatines are very short, so that the pterygoid fossa extends as far forward as the third molar and sometimes almost as far as the second molar. (4) The postorbital constriction is less than 0.80 of the interorbital breadth. (5) In fully adult individuals both the sagittal suture and the frontoparietal suture ankylose completely, so that there remain no visible sutures on the dorsal surface of the skull from the anterior edge of the frontals to the posterior edge of the parietals. (6) In lateral aspect the lateral lip of the infraorbital foramen is vertical to the occlusal plane, or inclined with the top forward, and the top of it reaches the maxillo-premaxillary suture.

The above six characters distinguish *Ratufa* (which constitutes the tribe Ratufini), from other Sciurinae of the Indian and Indo-chinese subregions as follows: *Sciurotamias* by 1, 2, 3, 4, 5, and 6; subtribe Callosciurina by 1, 2, 4, and 5; and *Funambulus* by 1, 2, 3, 4, and 5.

*Systematic History*.—Gray's (1867, p. 273) original characterization of *Ratufa* is not meaningful today. It consisted of "Tail elongate, longer than the body and head; large-sized." The name *Ratufa* was evidently meant as a subgeneric designation, and included only

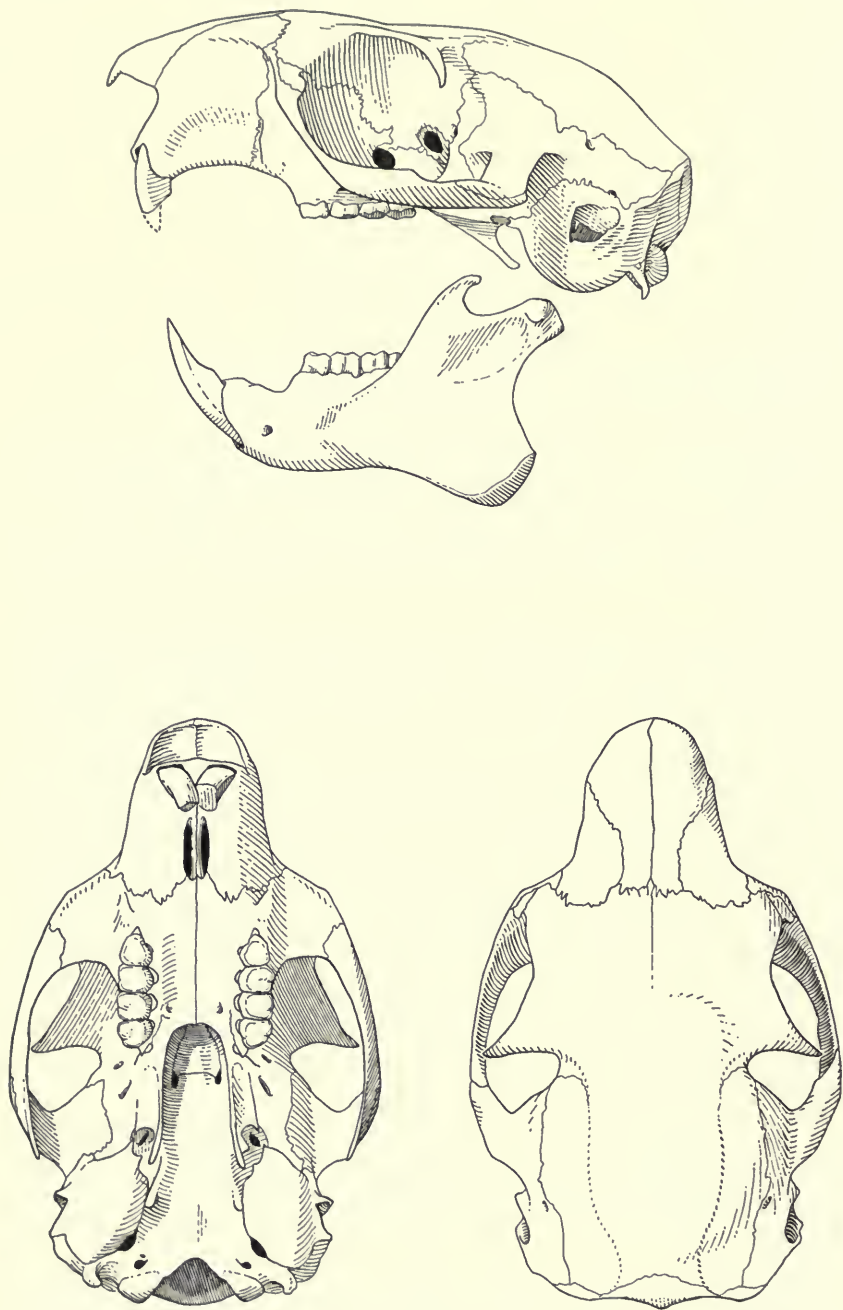


FIG. 1. Skull and left mandible of the pied giant squirrel, *Ratufa bicolor*, AMNH No. 83440,  $\times 1$ . Note generic characters described in text. For usage of skull anatomy consult Moore (1959, figs. 1-5).



the species *Sciurus indicus*. Farther on in the same paper he placed giant squirrels *macroura* of Ceylon, *bicolor* of Java, and *ephippium* of Borneo in a subgenus *Rukaia* under a genus *Macroxus*, but admitted no close relationship between *indicus* and the other three.

When Robinson and Kloss (1918) published a list of the squirrels of the Oriental Region, they employed the nine polytypic species of *Ratufa* which were then currently accepted: *macroura*, *indica*, *bicolor*, *notabilis*, *ephippium*, *affinis*, *gigantea*, *phaeopepla*, and *melanopepla*. Hayman and Holt (*in* Ellerman, 1940) followed that arrangement 22 years later. At the same time, however, Chasen (1940) reduced *notabilis*, *ephippium*, and *melanopepla* to subspecific status, and Zahn (1942) reduced *phaeopepla*, *gigantea*, and *indica* to subspecies. Ellerman and Morrison-Scott (1951) accept as species *macroura* on Ceylon, *indica* in the Indian Subregion and *bicolor* in the Indochinese Subregion. None of these authors, except Zahn, gave reasons for their decision or characters distinguishing the species, and as will be shown, the arrangement we present with reasons for decisions and characters for species, differs from that of Zahn (1942).

#### KEY TO THE SPECIES OF *RATUFA*

1. Crown sharply separated from nape by a distinct color band between ears . . . 2  
Crown pelage color connected with that of nape . . . . . 3
2. Digits black and ear-tufts inconspicuous . . . . . *macroura*  
Digits maroon or buff and ear-tufts conspicuous . . . . . *indica*
3. Light mark on thigh; no black mark on chin . . . . . *affinis* [extraterritorial]  
No light mark on thigh; small black mark on chin . . . . . *bicolor*

*Intragenetic relationships*.—It is suggested by the key to the species above and by the species diagnoses which will follow, that *macroura* is more closely related to *indica* than to *bicolor* or *affinis*. This is what would be expected, of course, on geographical grounds, and we think that it could also be demonstrated in characters of the skull. It seems desirable to point it out, however, because of a general similarity of appearance between some forms of *macroura* on Ceylon and forms of *bicolor* on Java and Bali (see Moore, 1960, p. 13).

We could find no discrete descriptive characters of the skull which distinguish geographically adjacent pairs of these species. Some trends are apparent, but variation in them is considerable. For instance, the zygomatic process of the squamosal possesses an elevated ridge which rises to somewhat of a peak, and in lateral view makes (in adults) a distinctive second superior process on the zygomatic arch. This characterizes the USNM *macroura* material, somewhat variably characterizes the AMNH *indica* material, occurs in nearby



TABLE 2. Body and Skull Dimensions of Type Specimens of the Genus *Ratufa* in the Indian and Indochinese Subregions.  
(in millimeters).

	BODY			SKULL						
	Head & Body	Tail	Hind Foot	Total Length	Mas- toid Breadth	Length Nasals	Dia- stema	Palatal Length	Bullar Length	Crown Length P-M <sup>3</sup>
<i>melanochra</i>	355	365	84	70.0	30.3	21.9	15.7	31.9	14.2	14.3
<i>dandolena</i>	377	415	78	..	..	21.7	14.5	31.1	..	..
<i>sinhala</i>	344	309	76	63.7	28.4	19.8	12.8	28.0	13.0	12.0
<i>superans</i>	450	505	95	79.7	35.4	26.5	17.7	35.0	15.5	16.2
<i>bengalensis</i>	450	460	80	..	31.2	25.5	16.0	33.5	16.2	16.4
<i>centralis</i>	341	423	82	71.8	30.4	23.2	15.4	32.2	14.5	14.9
<i>dealbata</i>	369	417	86	71.3	30.8	24.7	15.0	31.7	14.9	14.4
<i>lutrina</i>	397	520	104	73.8	34.8	22.5	17.0	34.3	15.6	14.1
<i>macruruoides</i>	460	400	92	76.9	36.2	24.1	16.9	34.9	15.7	14.6
<i>felli</i>	365	435	83	73.0	35.7	24.5	16.1	31.5	16.6	14.8
<i>stigmoma</i>	417	477	97	79.4	36.7	26.8	17.3	34.6	16.5	14.9
<i>phaeopepla</i>	405	500	91	76.5	33.8	24.0	16.0	35.0	16.0	14.5
<i>marana</i>	460	520	93	74.0	32.7	25.1	15.7	34.8	15.2	14.5
<i>leucogenys</i>	370	435	84	70.9	32.7	21.4	15.7	32.6	14.8	14.1
<i>sinus</i>	377	425	85	72.5	33.0	25.0	16.0	33.6	14.6	14.1
<i>smithi</i>	415	500	94	67.4	32.1	22.0	14.3	30.0	13.7	12.9

Mt. Victoria specimens of *R. bicolor gigantea* but not in Mt. Popa ones a little farther away. In the rest of *bicolor* and in *affinis* this process does not appear to occur with frequency.

This skull character might be taken as unexpected support for Zahn's (1942) recognizing *macroura*, *indica*, and *gigantea* as conspecific, but not *hainana* and *stigmosa* which he included (all grouped because of ear tufts). There is, moreover, in the ANSP material a Philadelphia Zoological Park specimen without data of origin, which is surely a cross between *Ratufa indica* and *R. bicolor*, for it displays some of the characters of each. However, since Hill (1939 and 1942) has easily bred both *macroura* and *indica* in captivity, it seems likely that this specimen results from a cross made in captivity and cannot be represented as a natural intergrade between *indica* and *bicolor*, suggesting that they should be treated as subspecies. In the diagnoses of the species *bicolor* and *indica* in the present paper we have offered a total of seven pelage characters which clearly distinguish these two as species.

In the present study it has also become clear that the extraterritorial *Ratufa affinis* is taxonomically the most distinct of the four species, although one can certainly say that *indica* is more spectacular. The equatorial giant squirrel *affinis* is the only one of the four species with three pelage characters distinguishing it from all three other species.

Rather little correspondence with the relationships of the species of *Ratufa* described above is seen in the exceedingly scanty knowledge of bacula of this genus. Dammerman (1931, p. 454) figured and described the baculum of *R. b. bicolor* of Java as "a simple short bone of 9.4–9.9 mm. length, slightly upcurved; the basal end expanded and hollowed; the apex narrowed and flattened horizontally." From the other end of the range of this species, upper Burma, Pocock (1923, fig. 20, E and F) figured a baculum of *R. b. gigantea* which is very similar to the one from Java, but has the distal, flattened, ventral surface provided with four rows of small bony spicules. Pocock (1923, fig. 20, G and H) illustrated a baculum of *R. indica* showing it to be strongly curved upward distally, spread at the curvature, tridentate at the tip, and grooved or hollowed on its anteroventral surface. Prasad's (1954, fig. 4, D, E, and F) excellent illustrations of a baculum of *R. indica maxima* from Coorg or Mysore agree with Pocock's *indica* (a zoo specimen with no locality data) in the characters of base, amount of curvature, and lateral spread at curvature. Prasad's *indica*, however, does not show a hollow in its anterior sur-

face, ends in a single nob that is slightly bilobed and has rows of bony spicules. Hill (1936, fig. 6, E and F) illustrated the baculum of *R. macroura* [*dandolena*] of Ceylon, showing that it has the 90-degree bend, widening at the bend, and a tridenticulate tip.

In sum it appears that although variable, the bacula of *bicolor* may be distinguished easily from the equally variable ones of *indica*. However, until more published examples reveal the extent of variation, the existence of a real distinction between the bacula of *indica* and *macroura* is much less certain.

It must be added that Hill (1940) reports rather striking differences between the glans penes of *R. macroura dandolena* and *R. m. melanochra*, and that his illustration of the glans of *melanochra* is disconcertingly more like that of Prasad's (1954, fig. 4, A, B, and C) *R. indica maxima* than that of *R. macroura dandolena*. Much needed are further scientific reports on the glans penes and bacula of these and other subspecies (with the capture locality of each specimen and the identifying characteristics of each captive precisely stated) to demonstrate whether genital characters support or deny the species difference between *macroura* and *indica* which we now consider well established by our present study of characters of the pelage.

The body and skull dimensions presented in Table 2 are measurements made and recorded by one of us (Tate) entirely of type specimens. These are offered here not as anything faintly resembling adequate representation of the subspecies or species, but as a rough indication of the dimensions likely to be found in this genus within the Indian and Indochinese subregions.

### **Ratufa macroura** (Pennant)

*Definition.*—*Ratufa macroura* is the Ceylonese giant squirrel, which shares the southern India range of *R. indica maxima* but occurs without a competing giant squirrel species in Ceylon.

*Diagnosis.*—*Ratufa macroura* has the following pelage characters: (1) The crown is black or blackish. (2) The digits are black or blackish. (3) The dorsal pelage of feet, ankles, and forearms is yellowish buff. (4) Ear tufts are present but small and short, extending no more than 5 mm. beyond the skin of the ear tips. (5) A light-colored band crosses between the ears, separating crown from nape.

The above characters distinguish *macroura* from the other species of *Ratufa* as follows: *indica* by 2 (ankle part of), 3, and 4; *bicolor* by 3 and 5; *affinis* by 1, 2, 4, and 5.

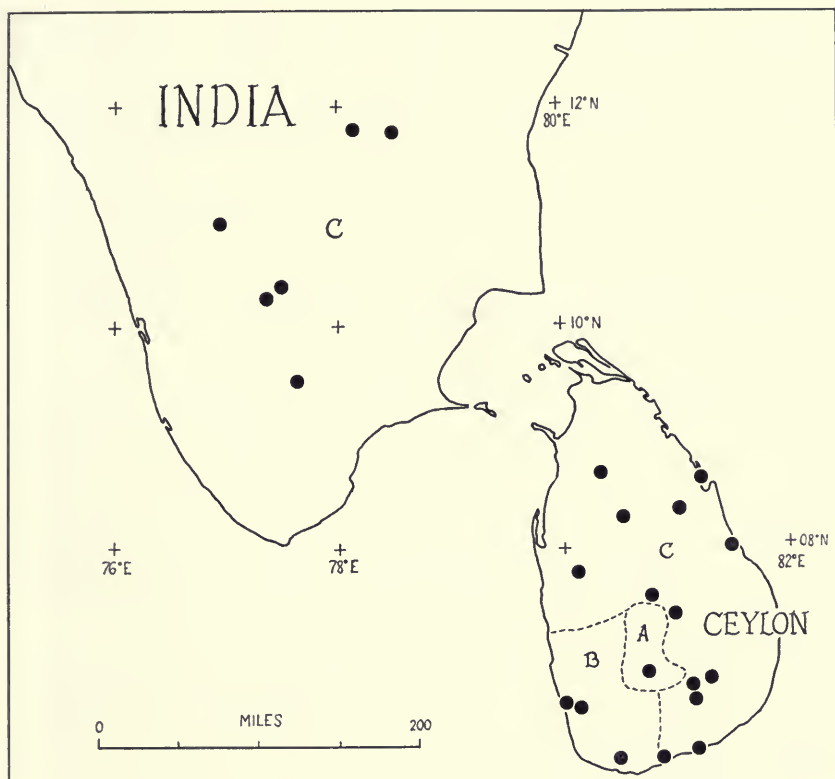


FIG. 2. Entire species range of the Sinhalese giant squirrel *Ratufa macroura* as revealed by material examined. Subspecies: A, *macroura*; B, *melanochra*; C, *dandolena*.

*Relationship to other species.*—Zahn (1942) treated *macroura* and *indica* as one species. We know of no evidence of intergradation between *macroura* and *indica*, and Abdulali and Daniel (1952) in their study of geographic variation in the species *indica* evidently observed none. The occurrence of *R. macroura* in a considerable geographic area within the range of *R. indica* in southern India without evidence of intergradation thus far, requires that the evidence regarding status be considered in detail.

There is in the locality records presented here for *R. m. dandolena* (fig. 2) and *R. i. maxima* (fig. 3) some fragmentary evidence that in southern India where populations of these forms are geographically sympatric, they may be ecologically segregated. The available elevations of Indian localities where *R. macroura dandolena* were col-

lected are relatively low (1000, 2000, and 3000 feet); whereas those for *R. indica maxima* tend to be higher (3200, 3285, 3300, 3500, 3500, 3500, 4000, 4200, 4500, 5000, 6100, and 6500 feet). Both species were taken in the Palni Hills, two examples of *macroura* at 3000 feet on the north slope, one of *indica* at 4000 feet on the north slope, and one of *indica* on the summit (at Kodaikanal which is 5500 feet). It appears therefore that the two species may be segregated by elevation, a circumstance which is not surprising in pairs of closely related and geographically sympatric species, and which evidently minimizes interspecific competition, enabling the two closely related species to evolve further in the same geographic area.

The light coloration of *macroura* makes it seem more suited to a habitat of dryer, perhaps deciduous forest, and the generally dark color and preponderance of black in *R. indica* suggest that it is better suited to living in darker, denser, evergreen rain forest high in the mountains or on the windward slopes of the Western Ghats. The geographic distribution of these two species on the southernmost part of the mainland is further suggestive of this sort of ecological segregation. Khajuria (1955) listed both *R. i. indica* and *R. macroura dandolena* as members of the "humid element" of the mammal fauna of the Deccan. In view of the evidence advanced here, it appears that *R. m. dandolena* may now be better regarded as belonging to the mammalian fauna's "semi-humid element" of Khajuria's classification.

It may be noted that as revealed by Abdulali and Daniel (1952, color plate) the named forms of *indica* occupying the Western Ghats form something of a color cline in which the lightest form, which is most like *R. m. dandolena*, is the most distant from *dandolena*, and the darkest form, which is least like *dandolena*, is the one closest to and sympatric with *dandolena*. Less strikingly but correspondingly, the lightest-colored subspecies of the species *macroura* is the one which is sympatric with the very dark subspecies of *indica*, and the blackest subspecies of *macroura* is geographically the most distant from the area of overlap with the dark subspecies of *indica*. This status appears to represent the phenomenon known as character displacement described and discussed by Brown and Wilson (1956, p. 49).

*Intraspecific variation.*—Varying sexual dimorphism in size is attributed by Phillips (1935) to the several subspecies of *macroura*. He finds the males larger than the females of the subspecies *macroura* in samples of three males and six females, and in foothills



material of *dandolena* in samples of five males and four females. But in samples of five males and six females of subspecies *melanochra* he found the females larger, and in the largest samples (Phillips, 1935, p. 224) of eleven lowland males and nine lowland females, that we here regard as *dandolena*, he found the sexes very similar in size. We suggest that the supposed sexual dimorphism is an artifact of the small samples, and that larger samples would show the sexes to be alike in size.

The averages and maxima that Phillips (1935, pp. 218–225) gives for body measurements of the several subspecies of *macroura* do suggest the existence of general size differences between the subspecies. The order of size is from *melanochra*, the largest, down through *macroura* to *dandolena* (see data in subspecies accounts of the present paper).

### **Ratufa macroura macroura** (Pennant)

*Sciurus macrourus* Pennant, 1769, Indian Zool., 1, pl. 1, and text.

*Sciurus ceylonicus* Erxleben, 1777, Syst. Regn. Anim., p. 416.

*Sciurus ceilonensis* Boddaert, 1785, Elench. Anim., 1, p. 117.

*Sciurus tennenti* Blyth, 1849, Jour. Asiatic Soc. Bengal, 18, p. 600.

*Sciurus macrourus* var. *montanus* Kelaart, 1852, Prod. Faun. Zeylon., p. 50.

*Sciurus macrurus* Blanford, 1891, Fauna Brit. Ind. . . . Mammal., p. 374.

*Types*.—*Sciurus macrourus*, not seen, from "Ceylon and Malabar," restricted by Phillips (1933) to "the highland jungles of the Central and Uva Provinces," Ceylon; *ceylonicus*, *ceilonensis*, *montanus*, and *macrurus* are misspellings or alternative names proposed for earlier names given here; *S. tennenti* not seen, and not found by Robinson and Kloss (1918, p. 185).

*Material examined*.—Pattipola, C. P. [Central Province], Ceylon, 6210 feet (B.M.), two.

*Discussion*.—This is said to be a highland form (Phillips, 1935). It is apparently known only from specimens from the one locality, and is distinguished in these specimens by white tips on the hairs of its black tail, and a grizzled gray line along the sides between the black back and yellowish venter.

*Dimensions*.—Phillips (1935, p. 218) alleges sexual dimorphism in this form, and provides averages of measurements in millimeters of three males and six females: length of head and body, males 346, females 375, length of tail, males 371, females [384], length of hind foot, males 68, females 71; length of ear, males 27, females 25.3. He records weights of two females that were evidently each three



pounds, four ounces. For the average length of tail for the six females above, Phillips (1935, p. 218) actually gives "365 mm. (15.1 in.)." This figure in millimeters is less than length of head and body in the females, which seems a little improbable, less than length of tail in the males, which seems a little improbable, also, and does not equal 15.1 inches. The figure 15.1 inches does exceed Phillips' averages for length of body of the females and also length of tail in the males. Assuming 15.1 inches to be more correct, we have provided its equivalent in millimeters in brackets above.

### **Ratufa macroura melanochra** Thomas and Wroughton

*Ratufa macroura melanochra* Thomas and Wroughton, 1915, Jour. Bombay Nat. Hist. Soc., 24, p. 36.

*Type*.—BM No. 15.7.1.4, adult female from Kottawa, elevation 280 feet, Southern Province, Ceylon, collected April 12, 1913, by E. W. Mayor.

*Material examined*.—"Pasdon, Corola," Ceylon (BM), one; "Anasigalla," Matugama, W. P. [Western Province] (BM), one; Kalutara, Matugama, Western Province (BM), one.

*Discussion*.—This is apparently a geographic race occupying all the wet lowland area, which lies southwest of the highlands between the highlands and the sea (Phillips, 1935). It is like *R. m. macroura* in having a yellowish venter and a black back and tail, but differs from it by having no white-tipped tail hairs or gray line along the side.

*Dimensions*.—Phillips (1935, p. 221) provides averages of measurements in millimeters of five males and six females: length of head and body, males 369, females 360; length of tail, males 387, females 388; length of hind foot, males 74, females 73.5; length of ear, males 25, females 27; weight, males 3 lb. 6 oz., females 3 lb. 2 oz.

### **Ratufa macroura dandolena** Thomas and Wroughton

*Ratufa macroura dandolena* Thomas and Wroughton, 1915, Jour. Bombay Nat. Hist. Soc., 24, p. 36.

*Ratufa macroura sinhala* Phillips, 1931, Ceylon Jour. Sci., Sec. B, 16, p. 215.

*Types*.—*Ratufa m. dandolena*, BM No. 15.7.1.5, adult female, from Wellawaya, Uva Province, Ceylon, 608 feet, collected July 6, 1913 by E. W. Mayor, *sinhala*, BM No. 31.1.12.3, adult male collected at Nikawewa, near Kantalai, North Central Province, 250 feet, February 21, 1929 by W. W. A. Phillips.

*Material examined*, from Ceylon.—“Mousa Kanda,” *Gammaduwa*, C.P. [Central Province] (BM), one; Pukpitiya, Gammaduwa, Central Prov., 2000 feet (BM), one; Nikaweratiya, N.W.P. [North-west Province] (USNM), three; Tinnpani [Tirappane], N.C.P. [North Central Province], 275 feet (BM), one; Bintenna, Eastern Province (BM), one, (USNM), one; Mankeni, Eastern Prov. (BM), two; Maha Oya, Eastern Prov. (BM), three; Wellawaya, Uva Prov., 608 feet (BM), one; Kumbukkan, Uva (BM), one; Tellula, Uva Prov., 300 feet (BM), one; Ranna, S.P. [Southern Province] (BM), one; Hambantota District, S.P. (BM), two; “Wawonia” (USNM), seven; “Candelay” (USNM), two.

*Material examined*, from southern India.—Kombu, south Coimbatore (BM), one; Chettiri Range, Salem District, Eastern Ghats, 2000 feet (BM), two; Kurumbapatty, Salem District, Eastern Ghats (BM), two; seven miles north of Gungwadoria, north slope Palni Hills, 3000 feet (BM), one; north slope of Palni Hills, 3000 feet (BM), two; Shrivilliputtur, Madura, southern India, 600–1000 feet (BM), four.

*Discussion*.—This geographic race of *Ratufa macroura* occupies forests of the dry lowlands of Ceylon and also an area in southern peninsular India. It is distinguished from the black-backed, black-tailed other two subspecies by having dorsal pelage entirely brownish gray except for the black patch of the crown and varying a blackish area across the shoulders “and middle line of rump.” The tail hairs have longer light tips than do those of *R. m. macroura* and these produce a much grayer overlay that obscures the black part of the hairs. The short midventral pelage of tail is consistently whitish. Tails on which the pelage is old, worn, and curling at the tips may be bleached to the color of the venter (yellowish buff). This description is based on Thomas and Wroughton (1915a, pp. 36–37) and notes on the United States National Museum material.

Phillips (1935, pp. 221–223) regards *dandolena* as a subspecies confined to forests of the foothills of the central highlands of Central and Uva provinces, and distinct from *sinhala* which Phillips recognizes as occupying the dry lowlands of Ceylon. The characters that he attributes to *dandolena* on a sample of nine in his arrangement appear to us to describe intergrades between subspecies *macroura* and Phillips' subspecies *sinhala*. Since no character distinguishes Phillips' concept of *dandolena* from both the upland *macroura* and lowland *sinhala*, and the intergrade characteristics are not shown to be constant over a considerable geographic area, it seems better to

recognize only the two subspecies, upland *macroura* and lowland *dandolena* including the foothills specimens as intergrades. Neither Zahn (1942, p. 13) nor Ellerman and Morrison-Scott (1951, p. 497) have followed Phillips' arrangement of *dandolena* and *sinhala*.

*Dimensions*.—Phillips (1935, p. 224) provides averages of measurements in millimeters of 11 males and nine females from the lowlands of Ceylon: length of head and body, males 331.2, females 329.8; length of tail, males 330, females 350.6; length of hind foot, males 64.2, females 65.2; length of ear, males 24.1, females 25.1. Weights of one male and one female, respectively, are 2 lb. 5 oz., and 2 lb. 8 oz.

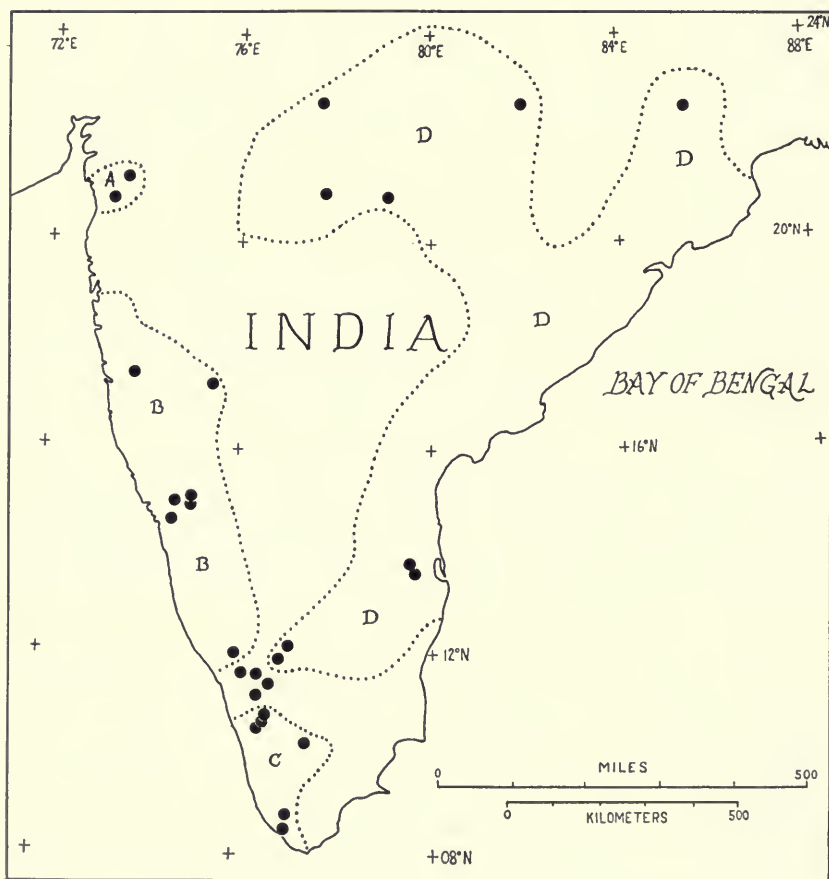


FIG. 3. Species range of the Indian giant squirrel, *Ratusa indica* as revealed by material examined. Subspecies: A, *dealbata*; B, *indica*; C, *maxima*; D, *centralis*.

***Ratufa indica* (Erxleben)**

*Definition.*—*Ratufa indica* is the principal giant squirrel species which occupies the mainland of the Indian Subregion.

*Diagnosis.*—(1) The ears have maroon tufts which extend about 20 mm. beyond the skin of ear tips, and which are not pointed but instead have a great many hairs about the same length. (2) There is a narrow, dark, usually maroon stripe extending ventroposteriorly from the anterior edge of each ear, and separating the light-colored side of the face from the still lighter-colored bib on the side of the neck. (3) There is a contrastingly-colored line which passes in front of the ear and meets its fellow at the back of the crown between the ears and separates crown from nape. (4) Some or all of the dorsal pelage of the sides, back, and tail is maroon (when the pelage is not badly worn and faded); the remainder is black.

The above characters distinguish *Ratufa indica* from the other species as follows: *macroura* by 1, and 4; *bicolor* by 1, 2, 3, and 4; and *affinis* by 1, 2, 3, and 4.

*Discussion.*—We are indebted to Abdulali and Daniel (1952) for their record and analysis of the relationships of pelage color differences to geography in this species, and no deprecation of the value of their work is implied by our taking a stand for recognition of subspecies which are more strongly marked and have greater geographic range and fairly large areas of intergradation. See Figure 3.

Moore (1960, p. 13) has drawn attention to how the distribution of this species bears on the Satpura hypothesis.

***Ratufa indica dealbata* (Blanford)**

*Sciurus indicus* var. *dealbatus* Blanford, 1897, Jour. Bombay Nat. Hist. Soc., 11, p. 299, plate A, fig. 1.

*Type.*—B.M. No. 96.11.7.6, adult male from Mahal, Dangs, India, collected April 6, 1896, by R. C. Wroughton.

*Material examined*, all from India.—“Khandeesh ” Dangs (B.M.) one; “Mahal ” Dangs (B.M.) one (topotype); Mheskatri Surat, Dangs (B.M.), one; Songadh, Nadsari District (B.M.), one.

*Type description.*—*Ratufa indica dealbata* has the appearance of an albinistic *indica*. The dorsal coloration of type examined in 1951 is white above, becoming yellowish white on the thighs. The ear tufts and anterior part of face are yellowish white. The tail is almost white except for a darker shade on the basal two to three inches, caused by dark subterminal bands on the hairs which occupy the



greater part of the length of the tail hairs. The under parts are white with a trace of yellowish on the insides of the hind legs.

*Discussion.*—The original recognition of the existence of this form came from Blanford's report on Wroughton's collection of three specimens from the Dangs and Wroughton's examination of a captive specimen from the same place. Although Blanford's description and color plate left no doubt as to the distinctiveness of these specimens, subsequent authors (e.g., Ellerman and Morrison-Scott, 1951) have understandably been reluctant to accept this material as characteristic of a population of giant squirrels inhabiting a particular geographic region. Salim Ali however, definitely established the continuing existence of a population of these very pale squirrels in the Dangs fifty years after their original discovery there by Wroughton in 1896. Salim Ali collected six specimens of them in two localities additional to the type locality of Mahal (Abdulali and Daniels, 1952). The area known thus far to be occupied by these cream buff giant squirrels remains small. Nevertheless, the fact that they occupy the northwest extension of the species range, and the striking character of their local color difference, seem to justify recognizing them as a subspecies.

Although the status of *dealbata* as a subspecies is accepted, some uncertainty remains about its color characters. The one principle character is well understood: the dorsal pelage is whitish or cream buff (or as Blanford says "pale rufescent sandy"). Blanford says that this becomes "slightly more rufous on the posterior portion of the body and on the outside of the hind limbs, and . . . brown on the outside of the forelimbs and on the basal portion of the tail." (His artist confined this "brown" of the "forelimbs" to the hands, probably correctly.) Whiter than the above were the "forehead, a band down the back, all the tail except the basal portion, and the lower parts. . . ." The tufted ears, Blanford said, were "bright rufus," and although that is how Blanford's colored plate showed them, when one of us (Tate) examined the type specimen in 1951, he recorded the ear tufts as "yellowish white." Abdulali and Daniel (1952) who had four specimens, say "Ear tufts brown."

Tate's notes indicate that the darkness of the basal portion of the tail is due to long, dark, subterminal bands on the tail hairs there.

While conforming otherwise to the above description, the little colored figure of *dealbata* presented by Abdulali and Daniel (1952) shows the color patch between the ears as dark (brown) contrasting

with the cream buff dorsal pelage. Abdulali writes (letter of March 6, 1959), however, that "the colour plate is erroneous . . . [in showing] a dark patch between the ears; . . . there is no white or pale patch between the ears [either], and the grizzled whitish of the nape and back is separated from the white of the forehead and snout by an almost straight line between the ears."

*Dimensions*.—Blanford's (1897, p. 301) original description includes measurements of a pair of adults of this subspecies taken in millimeters by R. C. Wroughton, who collected the animals: length of head and body, male 369, female 370; length of tail, male 417, female 408; length of hind foot, male 75, female 69.

### ***Ratufa indica indica* (Erxleben)**

*Sciurus indicus* Erxleben, 1777, Syst. Regn. Anim., p. 420.

*Sciurus purpureus* Zimmermann, 1777, Spec. Zool. Geogr. Quadr., p. 518.

*Sciurus bombayus* Boddaert, 1785, Elenchus Anim., 1, p. 117.

*Sciurus elphinstoni* Sykes, 1831, Proc. Zool. Soc. London, 1831, p. 103.

*Ratufa indica superans* Ryley, 1913, Jour. Bombay Nat. Hist. Soc., 22, p. 436.

*Types and co-types*.—*Sciurus indicus*, lost; *purpureus*, lost; *bombayus*, lost; *elphinstoni*, BM Nos. 79.11.21.578–579, two adult males marked "Dekkan, India," and 16.3.9.12, an old female from "Western Ghats, Dekkan, India," all collected by Mountstuart Elphinstone; *superans*, BM No. 13.6.21.3, an old female taken at Wote-kolli, South Coorg, December 28, 1912, by G. C. Shortridge.

*Material examined*, all from western peninsular India.—Devikop, 2000 feet, South Mahratta (BM), two; "Wotekolli," 2000 and 3200 feet, *southern Coorg* (BM), three; "Makut," 250 feet, *southern Coorg* (BM), one; Ghatmatha, Satara District (BM), one; Helwak, Satara District (BM), one; Samasgi, 2000 feet, Kanara Border, southwest Dharwar (BM), two; Yellapur, 1800 feet, North Kanara (BM), one; Landa [Londa], Bombay Pres. (AMNH), one; "Kanara," southern India (BM), three; "India" (USNM), one.

Pennant (1771, p. 281) described this squirrel well "from a stuffed skin in Doctor Hunter's cabinet" and said it "Inhabits Bombay," but he gave it no name. The scientific name *indicus* and the synonyms *purpureus* and *bombayus* cited above were all frankly proposed as scientific names for Pennant's Bombay squirrel, and all three of their Latin descriptions of it show some direct translation from Pennant's English description. The Erxleben description of *indicus* we translate, ". . . tail as long as body, with tip orange. Length of [head and] body 16 inches, tail 17. Tips of ears tufted. Head, back, sides,



upper part of legs, thighs and tail dull purple. Inferior part of legs and thighs, with the belly, yellow . . .”

*Discussion.*—Possibly from just south of the Dangs for something like 100 to 150 miles to Poona, but definitely at Bhimashankar, a point 40 miles directly east of Bombay, Abdulali and Daniel (1952) have demonstrated that the forest is occupied by giant squirrels that have hazel dorsal pelage instead of bay, and that have tails whitish distally for about half of their length. South-southwest of Bhimashankar about 25 miles, those authors found at Khandala 11 out of 12 specimens to be bay instead of hazel, but at Khandala an average of 0.40 (0.30 to 0.52) of the tail was whitish. Farther south they found bay dorsal color continued and whitish tip to the tail averaged only 0.25. This evidence suggests intergradation between the cream buff *dealbata* and the bay *indica*, and Abdulali and Daniel (1952) included the hazel material in the subspecies *indica*. However, if the hazel color and half white tail should prove to be constant in further material from the Western Ghats from Bhimashankar up to the vicinity of the Dangs, there would be a case for recognizing the giant squirrel of this area as a subspecies, *R. i. elphinstoni*. Abdulali writes, however (letter of March 6, 1959), that the additional material received by the Bombay Natural History Society since his 1952 paper was written had yet included “no hazel coloured specimens from between Bhimashankar and the Dangs . . .”

*Dimensions.*—Riley (1913 p. 436) provides ranges of some measurements taken in millimeters on an unstated number of *indica* specimens from Dharwar and North Kanara: length of head and body, 340–380; length of tail, 370–446; length of hind foot, 73–77; length of ear, 25–33; greatest length of skull, 68–74; basilar length, 53.5–59; length of toothrow, 14.3–15.5; length of diastema, 15.5–18; length of nasals, 24.5–26; and zygomatic breadth, 46–49.5.

Southward in the range of *R. i. indica*, a sample of 14 specimens considered identical with *R. i. indica* in color, was described as a new subspecies (Riley, 1913, p. 436), *R. i. superans*, because an unstated number of the sample was discretely and notably larger than an unstated number of ordinary subspecies *indica* from Dharwar and N. Kanara. Abdulali and Daniel (1952) reported another sample of three large specimens from near Hassan, and accepted *superans* as a good subspecies. Ellerman (1940), Zahn (1942), and Ellerman and Morrison-Scott (1951) have also accepted this as a good subspecies, but we are doubtful. Size alone in some mammals can evidently change with density of population (Scheffer, 1955), and in absence

of other differences "*superans*" is regarded here as atypical samples of the typical subspecies.

### ***Ratufa indica maxima* (Schreber)**

*Sciurus maximus* Schreber, 1784, Säugethiere, 4, p. 784, pl. 217B.

*Sciurus malabaricus* Scopoli, 1786, Del. Flora Fauna Insul., 2, p. 85.

*Sciurus indicus* var. *bengalensis* Blanford, 1897, Jour. Bombay Nat. Hist. Soc., 11, p. 303, plate B, fig. 2.

*Types*.—*S. maximus*, MNHN No. 93, adult female, from coast of Malabar, India, collected by Sommerat; *bengalensis*, BM No. 44.7.4.7, adult from "India."

*Material examined*, all from southwestern peninsular India.—"Cotengady Estate," 3500 feet [Nelliampathi Hills, *Palghat* Distr.], Cochen (BM), four; Kodaikanal, top of Palni Hills, Madras (BM), one; "Anamaad," 3200 feet, Malabar (BM), one; "Kukkal, Shola," 6100 feet (BM), one; near "Machur," 4500 feet (BM), one; "Ottacoolie Estate," 3300 feet, Malabar [Nelliampathi Hills, *Palghat* Distr.] (BM), one; Penmudi [Ponmudi], Travancore (BM), one; "Northern slopes Palni Hills," 4000 feet (BM), one; Trivandrum, Travancore (BM), one; "India" (MCZ), one; Kellengode [Kollangod], 3500 feet, S. India (AMNH), two; Nelliampathi Hills, 3500 feet (AMNH), one; Kil, Kotajiri, 5700 feet, Nilgiri Hills (BM), two; "Attikan," 5000 feet, Mysore (AMNH), one; "Mysore" (AMNH), four; Avalanche, 6500 feet, Nilgiri Hills (AMNH), one; Kalhatti [Falls], 4200 feet, Nilgiri Hills (AMNH), one; Mudumalai, 3285 feet, base of Nilgris (AMNH), two; Ootacamund, Madras, India (AMNH), one.

*Discussion*.—Blanford's (1897) subspecies *bengalensis* was described from a single specimen with locality unknown. Ryley (1913, p. 436) reported a sample of 10 from Coorg to be identical in color with the type of *bengalensis*. This color seen in Blanford's color plate of the type, and the color plate of Abdulali and Daniel (1952) is different from *indica* only by having a black tail. Since *bengalensis* seems to be present in pure form only in a small area, and since the one character distinguishing it from *indica* is possessed also by the adjoining subspecies to the south, *maxima*, it is difficult to regard *bengalensis* as anything but a rather attenuated area of intergradation between subspecies *indica* and *maxima*. Obviously, it does not fit the characters of either of these, but it is intermediate.

From fifty miles south of Coorg in the Nilgiri Hills the American Museum of Natural History has material from Ootacamund and

Mudumalai which possesses the "*bengalensis*" color pattern, and Abdulali and Daniel (1952) report two other such specimens from the Wynaad Nilgiris. They report two further specimens from the Nilgiri Hills which differ from the *bengalensis* pattern only in having additionally a patch of black on the upper forelimbs (*not* the shoulders) but point out that this may perhaps be disregarded because it also occurs inconsistently in the subspecies *indica*. They then report that from Kotagiri, only ten miles east of Ootacamund, the material is colored in the *centralis* pattern (i.e. differing from typical *indica* in having a black tail and separate black shoulder patches). From Avalanche, about 10 miles in the opposite direction from Ootacamund, and from Kalhatti [Falls], which lies between two localities for the *bengalensis* pattern, the American Museum has specimens which approach the *maxima* color pattern more closely, but the feet are bay, the black of the shoulders is discontinuous, and the Kalhatti one has entirely red hind legs. (Incidentally, these approach Scopoli's type description of *malabaricus*, but could hardly be more obviously intermediate between all of these other bay-footed color patterns and *maxima*.) The point is made above that in the Nilgiri Hills the *bengalensis* color pattern intergrades through examples of the *centralis* pattern toward and very closely approaching the color pattern of *maxima*. Possibly they may mix so that all three patterns could be observed at one locality, or more than one pattern in one brood. If they do not, the details of intergradation would make an interesting field study.

*Pelage color*.—From the Nelliampathi Hills less than 50 miles south of the Nilgiri Hills the American Museum of Natural History has three specimens, two from Kellangode, all of which possess the color pattern which is typical for *Ratufa indica maxima*. This pattern is fore feet, fore legs, and hind feet Light Ochraceous-Buff; the shoulders and nape black entirely across from one upper fore leg to the other; tail, rump, and thighs entirely black with an incipient narrow black line extending forward in the middorsum; bib Light Ochraceous-Buff (XV) and face forward of the red subaural stripe about Apricot Buff (XIV); crown, subaural stripe, 20 mm. ear tufts, a small anterior portion of the nape, and the shanks of the hind legs Morocco Red; sides Ox-blood Red; ventral pelage (which is long and dense enough to hide the dark basal color of the hairs in two of the three) Warm Buff (XV); interaural patch Light Buff.

*Diagnosis*.—The subspecific characters of *maxima* are: the continuous black across the shoulders, the black rump, the light feet,



and the black tail tip, in that order of importance. The specimen from the Palni Hills which Abdulali and Daniel (1953, p. 731) describe as a variant of *maxima* does not therefore seem importantly different. Moore wrote Humayun Abdulali to ask if in Bombay Natural History Society material *maxima* always has a single, continuous shoulder patch and *centralis* always two separate shoulder patches. He responded (letter of March 6, 1959) that this is so.

*Habits*.—Hutton (1949, p. 691) recorded observations of *maxima* in the High Wavy Mountains about sixty miles southwest of Madurai, some of which contribute toward understanding of factors which may influence their distribution: "A very common animal throughout the [broad-leaved] evergreen forests. It is not found in the deciduous forest. . . . They often use the same nests for some years . . . keeping them repaired and adding to them each year. I have examined several nests. . . . Their average size was 2 feet in diameter and the inside looked as if it would hardly accommodate an adult squirrel, being barely a foot across. They bring forth two lots of young each year, . . . one lot in September and another lot in March, the average per litter being two. Once only have I seen three. The adults . . . have no sense of territory. . . . When the young are past the milk-diet stage, both parents help in the feeding. Quite often I have seen these squirrels foraging together; one on the ground collecting nuts, etc., which the one in the tree knocks down. Very occasionally one comes across a squirrel larder at the base of some tree, which may contain upwards of two measures of nuts and other hard fruit."

*Dimensions*.—Wroughton (1910, p. 889) provides several measurements of an unstated number of *R. i. maxima*, perhaps only one: length of hind foot, 80; greatest length of skull, 77; basilar length, 60; upper molar series, 15; length of diastema, 16.5; length of nasals, 24; zygomatic breadth, 49; interorbital breadth, 30.

### ***Ratufa indica centralis* Ryley**

*Ratufa indica centralis* Ryley, 1913, Jour. Bombay Nat. Hist. Soc., 22, p. 436.

*Type*.—BM No. 12.11.29.85, adult male from Bori, Hoshangabad Central Provinces, India, 1600 feet, collected February 13, 1912 by C. A. Crump.

*Material examined*, all from India.—Amarakantak, source of Nerbudda River (BM), one; Bori, 1800 feet, Hoshangabad (BM), five (topotypes); Balapalli, 1000 feet, Palkonda Hills (BM), one; Kollegal, Billigirirangan Hills, Coimbatore (BM), two; Chamarajnagar,

about 2500 feet, South Mysore (BM), one; "Gerung River, Manip-we" (BM), one; Koduru, 550 feet, Balapalli Range (BM), one; Luia, 1000 feet, Chaibassa, Bihar and Orissa (BM), three; Sangajata, 1300 feet, Chaibassa, Bihar and Orissa (BM), one; Dhain, 1400 feet, Hoshangabad (BM), two; no data (AMNH), two; Amraoti, Bastar [Berar] (AMNH), two.

*Pelage color*.—The subspecies *centralis* as exemplified by the Amraoti material is: Ox-blood Red on the dorsum, sides, ear tufts, and hind legs; black on the forelegs, shoulders (but separated by 30 mm. of red), and tail (which, however, pales at the tip to Light Buff XV); Cinnamon-Rufous (XIV) on the feet; Light Buff on the bib and intraural patch, but Buffy Brown (XL) on the side of the face; Liver Brown (XIV) on the crown.

*Dimensions*.—Miss Ryley (1913, pp. 436–437) provides ranges in millimeters of body and skull measurements of an unstated number of her hypodigm of about 20 specimens of *centralis*: length of head and body, 309–343; length of tail, 382–433; length of hind foot, 72–79; length of ear, 25–30; greatest length of skull, 69.5–74; basilar length, 50–58; length of tooth row, 14–15; length of diastema, 14–16; length of nasals, 21.5–24; and zygomatic breadth, 42–46.

Abdulali and Daniel (1952, p. 473) provide ranges and averages of two measurements in millimeters for 19 specimens of *centralis*: length of head and body, 300–380, average 340; length of tail, 390–450 (but an exceptional 270), average 405.

*Discussion*.—This well-marked although variable subspecies occupies low hills of central India, as its name suggests, and follows these eastward almost to Bengal. It also occurs in the Eastern Ghats, however, and southward along this chain to the state of Mysore and reaches the Western Ghats in the Nilgiri Hills where it intergrades in a confusing three-way mixture with *maxima* of the south and *indica* of the northwest.

*Habits*.—At Sangajata and Luia, Bihar, collector C. A. Crump took 13 specimens and wrote the following comments (Wroughton, 1915c, p. 107): "This handsome squirrel is gregarious and one of the most locally distributed animals I have ever come across. At Luia it inhabits a piece of jungle perhaps a mile square, and outside of this it is useless to search for it. Near Sangajata the favorite haunts were patches of jungle near the river, and though I passed through much of the Forest here, nowhere else, outside of the spots mentioned, did I see the large conspicuous nests made by this species. The call is a loud rattle. . . . This squirrel lives among the most

lofty trees, it can take huge leaps, and is equally at home on a smooth trunk or scrambling among the slenderest twigs. I have never seen it lower than about 12 feet from the ground . . ."

### ***Ratufa bicolor* (Sparrman)**

*Definition.*—*Ratufa bicolor* is the bibbed giant squirrel which ranges over the greater part of the Malaysian Subregion and Indochinese Subregion at least as shown in Figure 4.

*Diagnosis.*—*Ratufa bicolor* has the following characters of the pelage: (1) A large whitish or buff, bib-like area sharply marked off on the side of the neck is continuous with the color on the side of the face. (2) In most subspecies a broad, moustache-like, black line extends from the black rostrum down and back through the vibrissal patch and the whitish or buffy pelage on the side of the face. (3) There is a small black spot in the whitish pelage of the chin, often divided midsagittally and finely into two parts.

The above characters distinguish *Ratufa bicolor* from the other species of *Ratufa* as follows: *affinis* by 2 and 3; *indica* by 1, 2, and 3; *macroura* by 1, 2, and 3.

*Intraspecific variation.*—In Table 2 some measurements of nine specimens of the species *bicolor* provide a bare indication of the dimensions one may find in species *bicolor* in the Indochinese Subregion. The whole range of this species of giant squirrel, as revealed by the listings of Chasen (1940) and of Ellerman and Morrison-Scott (1951), extends from Nepal to Hainan, South Viet Nam, and Bali. No definition has previously been proposed for this broad concept of the species *bicolor*. It was somewhat of a practice in the past to include the forms south of Malacca Strait (*bicolor*, *baliensis*, *palliata*, etc.) in the species *bicolor*, but the mainland and insular forms north of that strait (*peninsulae*, *phaeopepla*, *gigantea*, etc.) were regarded as belonging in one or more separate species. Robinson and Kloss (1918, pp. 118, 195) thus recognized in what is now regarded the one species, several species separable at the Malacca Strait, the Isthmus of Kra, and along mainland lines less well defined. Although by 1922 Robinson and Kloss had evidently come to consider the above-named forms conspecific, Ellerman still accepted their 1918 classification for his "Families and Genera of Living Rodents" in 1940. No one has advanced any justification for recognizing a species division at the Malacca Strait in the first place, nor for abandoning it in the second; and we have empirically sought evidence on this.





FIG. 4. Distribution of the mainland subspecies of *Ratusa bicolor* which occur north of the Isthmus of Kra: M, *phaeopepla*; N, *leucogenys*; O, *smithi*; P, *felli*; Q, *gigantea*; R, *hainana*.

The pelage characters common to the forms of *Ratusa bicolor* southwest of the Malacca Strait are: (1) The dorsal body pelage is generally light tipped. (2) the tail hairs are generally light tipped. (3) The black moustachial line is obsolescent. Numbers 1 and 2 provide striking contrast with the pelage characters of all the forms (of species *bicolor*) north of Malacca Strait except *smithi*. Pelage characters common to the forms under discussion on both sides of the Malacca Strait are: (1) The ventral body pelage is bicolored. (2) There is a contrastingly light bib on the face and neck. (3) A

black triangular mark is found on the chin. (4) There is a light flash mark on the dorsal pelage of the fore legs. (5) A light mark also ornaments the hind foot. In view of the number and character of the differences and similarities, a better case is deemed to exist for regarding these forms as conspecific.

North of the Malacca Strait another place where the pied giant squirrels were regarded as divided into geographically juxtaposed species is at the Isthmus of Kra, where *melanopepla* and *phaeopepla* seemed to come together (Miller, 1913, p. 25; Robinson and Kloss, 1918, pp. 194-195; Ellerman, 1940, p. 389). The division of forms at the Isthmus of Kra was regarded as but doubtfully of species level by Robinson and Kloss (1918, p. 195), and restudy of the original series involved and consideration of new material leads us to conclude that it is at best a subspecies division. See the discussion here in the account of subspecies *R. b. phaeopepla*.

The next former alleged species division line farther north, which separated the alleged species *phaeopepla* and *gigantea* may be distinguished in refined form on our map, Figure 4, separating subspecies *gigantea* and *hainana* from subspecies *phaeopepla*, *leucogenys*, and *smithi*. The differences that we find involved here are: (1) Ear tufts occur in *gigantea* and *hainana* but not in the other subspecies. (2) Flash marks occur on the fore legs of *phaeopepla*, *leucogenys*, and *smithi*, but not on the other subspecies. (3) The white of the bib and cheeks rises up in front of the eyes in *gigantea* and *hainana* but does not in the other subspecies. These taxonomic differences are discussed in further detail below, particularly in the subspecies account of *gigantea*. One may note that much more taxonomic difference has been found between these subspecies groups here than between those at the Isthmus of Kra.

*Relationships to other species.*—Zahn (1942) has taken the present geographic line of separation as the one that parts the Indian species from the species *bicolor*. For our part, however, we find that separation to be at the subregional boundary, which may loosely be said to be the barrier imposed by the Ganges River and its valley (but see Moore, 1960). The maroon species *indica* is separated from the pied species of giant squirrel across the subregional boundary by a more impressive assortment of characters, each of which has wide geographic applicability beyond the subspecies mentioned: (1) A prominent whitish or buffy mark separates the crown from the nape in *indica centralis* but not in *bicolor gigantea*. (2) A dark line descending from the ear divides the bib into cheek and neck components in *cen-*

*tralis* but not *gigantea*. (3) The ears of *centralis* have large Maroon tufts, but those of *gigantea* have small black tufts. (4) Light-colored pelage covers the feet, wrists, and ankles of *centralis* but in *gigantea* these are black. (5) Large areas of the fresh dorsal pelage are Maroon in *centralis*, but the back of *gigantea* is only black. (6) A black or blackish chin spot is present in *gigantea* but not in *centralis*. (7) A black or blackish moustachial line extends ventroposteriorly from the rostrum in *gigantea* but not in *centralis*. This line is not to be confused or equated with the facial stripe described above as character number two, as Zahn (1942) did equate them.

On the basis of the above differences we consider the range of the species *Ratufa bicolor* to go as far north and west as Nepal. We presume that *bicolor* does not cross the Ganges River or intergrade anywhere with *Ratufa indica*. We regard all of the giant squirrels of the Indochinese Subregion to belong properly to the species *bicolor*. The range of the species as indicated by the material we have examined extends from its northwestern locality in Nepal some 1500 miles eastward across Assam, upper Burma, southern Yunnan, Tonkin, and southern Kwangsi to Hainan. The northwest to southeast extent of its range, including the extraterritorial part, is from Nepal to Bali. Indonesia, some 3000 miles.

In the Academy of Natural Sciences collection at Philadelphia we found a giant squirrel specimen with characters which seem definitely a mixture of those of species *indica* and *bicolor*. Nothing is known of its geographic origin, and it came to the Academy from the Philadelphia Zoological Garden. W. C. O. Hill (1939, 1942) has reported successful breeding in both species *macroura* and species *indica* in captivity, and in view of the origin of the Academy specimen it seems likely that it represents a species cross between captive specimens of *indica* and *bicolor*. A less likely origin would be a relict patch of forest, from which no other museum specimens were available to us, naturally inhabited by an interbreeding mixture of *indica*, *centralis* and *bicolor*, *gigantea*.

### ***Ratufa bicolor phaeopepla* (Miller)**

*Ratufa phaeopepla* Miller, 1913, Smithsonian Misc. Coll., **61**, no. 21, p. 25.

*Ratufa celaenopepla* Miller, 1913, Smithsonian Misc. Coll., **61**, no. 21, p. 26.

*Ratufa phaeopepla marana* Thomas and Wroughton, 1924, Jour. Bombay Nat. Hist. Soc., **24**, p. 227.

*Types*.—*Ratufa phaeopepla*, USNM No. 124235, adult male from Sungei Balik, Tenasserim, Burma, collected February 25, 1904, by

W. L. Abbott; *celaenopepla*, USNM No. 124149, adult male from Domel Island, Mergui Archipelago, Burma, collected January 26, 1904, by W. L. Abbott; *marana*, BM No. 14.7.19.107, adult female from Mt. Popa, dry zone of upper Burma, collected September 26, 1913, by G. C. Shortridge.

*Material examined*, from Thailand.—Me Ping River 195 miles N. of Bangkok (BM), one; Lai Yoke [Ban Sai Yoke] (BM), one; 20 miles west of Kampengpet, 450 feet (BM), one; Me Yam Valley, N. Phre 185 meters (BM), one; Me Taw Forest, Raheng (BM), one; Bank of Me Ping River, south of Hkampenpet, 120 to 180 feet (BM), two; Me Wong River, 53 miles E. of Um Pang, 800 feet (BM), three, (AMNH), three; 28 miles E. of Um Pang, 1750 feet (AMNH), two; "Wang Pratart Farm," Kam Peng Pet Prov. (CNHM), three; Ban Tong Ting (USNM), one; Raheng (USNM), one; Borphloy, Kanchanaburi (USNM), one; Klong Klung, Kamphaengphet (USNM), two, (CNHM), five; Doi Phu Kha (USNM), one; Pak Koh (NR), one; Koon Tan (NR), three.

*Material examined*, from Tenasserim, Burma.—Bankachon, V.P. (BM), four; Mergui (BM), one; Thagyet, Little Tenasserim River (BM), one; Thowngyoh [Theng-gan-ngok] (BM), one; Maliwun (AMNH), one; Taok Plateau (AMNH), one; "Bankusun" (BM), two; Victoria Point (BM), one, (USNM), two; Kisseraing Island (BM), two, (USNM), one; King Island (BM), one; Domel Island (USNM), two; Sullivan's Island (BM), one; Red Point (USNM), two; Sungei Balik (USNM), six; Telok Besar (USNM), five.

*Material examined*, from Upper Burma.—Kodugwe, Pegu Yoma (AMNH), one; Camp Pinmezali, Pegu Yoma (AMNH), two; Mt. Popa (AMNH), five, (BM), two; 20 miles N. of Toungoo (BM), one; 30 miles N. to N.W. of Toungoo (BM), two; Kokkagon (AMNH), one; "Shenege Chaung, 1000 feet, Suiges Ruen," Mandalay (BM), one; Taho, Kareni (USNM), one.

*Dimensions*.—From the describer's hypodigm of 16 specimens of *phaeopepla*, all collected by W. L. Abbott in southernmost Burma, we find the modal weight in 15 recorded on specimen tags by the collector to be four pounds. Only the pregnant female mentioned below weighed more, and the lowest weight,  $3\frac{1}{4}$  lb., is of an immature male. The collector's measurements of *phaeopepla* were: length of head and body, 365–415 (average 386); length of tail, 390–500 (466). Twelve of the 16 were males. The type of *celaenopepla* was a male weighing five pounds, according to W. L. Abbott's label. See weights reported for *R. b. gigantea*.



Re-examination of Miller's *phaeopepla* series of 16 specimens used in the original description, reveals 11 that are mature on the basis of ankylosis and tooth wear. The 11 range from 73.2 to 77.6 and average 75.5 in greatest skull length. The *peninsulae* available to Miller were only three, admissibly mature by the same criteria, but brought up to 12 by three adults more recently obtained from Kuala Lumpur, one from Bangnara, and five from Ban Don, the series at the U. S. National Museum ranges from 68.3 to 74.0 and averages 71.9. This difference from *phaeopepla* seems at least feebly to sustain Miller's proposition of a taxonomic break at the Isthmus of Kra, but we consider this to be at no better than the subspecies level.

*Pelage color.*—The newer U. S. National Museum material from Bangnara and from Waterfall, Trong, Thailand, includes three specimens with molt lines across the back showing that the new pelage of *peninsulae* is much blacker than the freshest pelage of Abbott's *phaeopepla* series. This seems also to validate Miller's statement that fresh pelage color distinguishes *phaeopepla* from *peninsulae*; although the fresh pelage of a molting immature from Rumpin River in Miller's hypodigm of *peninsulae* seems to us no darker than some in his hypodigm of *phaeopepla*.

*Diagnosis.*—Miller only distinguished *celaenopepla* from *phaeopepla* as having the fresh dorsal pelage much blacker. His type of *celaenopepla* is far darker than any U. S. National Museum *phaeopepla*, but none of the latter demonstrates by having a sharp molt line the ultimate blackness that may be reached by *phaeopepla*.

*Ratufa bicolor phaeopepla* occupies the southern two-thirds of Burma, a range about 800 miles long. It must be noted that Miller's material was all from the very southern end of the range of *phaeopepla*, and since this range as we see it, borders upon that of the conspecific *gigantea*, *felli*, *hainana*, and *leucogenys*, it requires also to be carefully distinguished from those subspecies. *Ratufa bicolor phaeopepla* is distinguished from *gigantea* and *hainana* by possessing a buffy flash mark spread across the dorsal surface of its fore legs, and by lacking distinct ear tufts; from *felli* by the dorsal pelage being blackish with no outstanding break in color from crown to tip of tail; from *leucogenys* by having bib and flash mark on fore leg more richly colored, Salmon Color (XIV) instead of the nearly white Cartridge Buff (XXX); from *peninsulae* by larger adult size.

*Discussion.*—W. L. Abbott noted that the USNM No. 124247 which he collected March 27, 1904, from Telok Besar in southern Tenasserim weighed 4½ lb. and had but a single fetus in the uterus.

It seems at least noteworthy that specimens from along the Me-wong River east of Um Pang [Ban Le Kathe], Thailand, have the pelage of their napes faded to form a prominent pale spot as is common in *leucogenys*. Since the bibs and flash marks on the fore legs of three seem also somewhat light for *phaeopepla*, these may be considered intergrades with *leucogenys*. The specimen from Borphloy [King Bo Ploei], Thailand, is likewise intermediate.

*Habits*.—Field observations from the northern and southern limits of the subspecies range: "Local and not very plentiful on Mt. Popa, only occurring in the heavy evergreen forest near the top of the mountain." (G. C. Shortridge in Wroughton, 1915a, p. 472.) "Fairly plentiful, but more difficult to obtain in thick evergreen jungle than in the deciduous forests further north, as in other places these squirrels become rust coloured during the hot season. Weight 3-4 lbs." (G. C. Shortridge in Wroughton, 1915b, p. 712.)

### *Ratufa bicolor leucogenys* (Kloss)

*Ratufa melanopepla leucogenys* Kloss, 1916, Proc. Zool. Soc. London, 1, p. 43.

*Type*.—BM No. 15.11.4.43, old female from Lem Ngop, southeast Siam, collected January 15, 1915, by C. B. Kloss.

*Material examined*, from southeastern Thailand.—Hinlap, 900 feet (BM), one; Krabin (BM), one; Sakerat (NR), one; Chanta-boon (AMNH), one; Twenty miles west of Kempenpet (AMNH), one; Twenty-eight miles east of Um Pang (AMNH), two; Me Wong River, fifty-three miles east of Um Pang (AMNH), three; Klong Yai (USNM), two; "Huey Yang," *Sriracha* (USNM), one; Kao Sabab (USNM), four; Nong Dom Ta (USNM), one; Nongkhor (USNM), two; Nong Mong Muang (USNM), one; Hoopbon [Ban Hup Bon] (USNM), one; Bor Phloy, Kanjanaburi (USNM), one; Ban Nong Bua (CNHM), one; Lem Ngop (CNHM), one.

*Material examined*, from Cambodia.—Mt. Pra (BM), one; "Diai, Melton" (BM), one; Samba [Sambor] (BM), one.

*Original description*.—"Characters.—Like *R. m. peninsulae* . . . but yellow of cheeks, fore limbs, and under surface markedly paler than the respective areas in that form, yellow on thighs more extensive and continued along the sides of the feet onto their upper surfaces, where it occupies a considerable area, while the yellow of the fore limb extends to the bases of the toes above."

*Pelage color*.—We made the following color notes from a sample of six specimens in the United States National Museum, and the



Ridgway color terms used by Kloss are added in parentheses: bib and flash mark on fore leg are Cartridge Buff (Ivory Yellow); venter Apricot Buff (Pale Orange-Yellow).

*Diagnosis.*—*R. b. leucogenys* differs from *phaeopepla* in having a paler bib and flash mark on the front leg, and in having a larger pale mark on the hind foot; from *hainana* by possessing a flash mark on the front leg and lacking ear tufts; from *smithi* by having no whitish tips on the dorsal pelage.

*Dimensions.*—Measurements of three adults provided by Kloss in millimeters in the original description: length of head and body, 370, 360, 345; length of tail, 435, 435, 450; length of hind foot, 79, 80, 79; greatest length of skull, 71, 73, 71; condylobasal length, 60.5, 61, 58.5; palatal length, 27, 27.7, 26.3; diastema, 16, 16, 14.7; length of maxillary toothrow, 14, 14.2, 14; interorbital breadth, 26.5, 29.5, 26.7; zygomatic breadth, 46, 44, 44.5. Sex is respectively female, male, male.

### ***Ratufa bicolor sinus* (Kloss)**

*Ratufa melanopepla sinus* Kloss, 1916, Proc. Zool. Soc. London, 1, p. 44.

*Type.*—BM No. 15.11.4.41, adult female from Koh Kut Island, southeast Siam, collected December 26, 1914, by C. Boden Kloss.

*Material examined.*—Koh Kut Island, southeast Siam (BM), one, (USNM), three.

*Diagnosis.*—This subspecies is most like *leucogenys* to which it is geographically adjacent, and differs from it by having uniformly clear black dorsal pelage and richer colored ventral pelage, about Orange-Cinnamon we note, but Kloss describes it as varying from Ochraceous Buff to Ochraceous Orange and Ochraceous Tawny in the center of the abdomen. He noted that the nasal bones were rather longer in *sinus* than in *leucogenys*, their posterior terminations being more in line with those of the premaxillaries.

*Dimensions.*—The original description provided measurements in millimeters of six adults, three of each sex. Ranges and averages of these are: length of head and body, 355–380 (366); length of tail, 415–450 (431); length of hind foot, 75–79 (77); greatest length of skull, 71–73 (71.9); condylobasal length, 59.5–61.2 (60.3); palatal length, 27–28 (27.3); length of diastema, 15.5–16.3 (15.8); length of maxillary toothrow, 14–14.2 (14.1); interorbital breadth, 28–30 (28.5); zygomatic breadth, (five specimens) 44–46 (45.1).

*Ratufa bicolor sinus* is not mapped in Figure 4.

**Ratufa bicolor smithi** Robinson and Kloss

*Ratufa bicolor smithi* Robinson and Kloss, 1922, Ann. Mag. Nat. Hist., [ser.] 9, 9, p. 89.

*Type*.—BM No. 26.11.17.3, old female from Langbian Peaks, south Annam, 6000 feet, collected April 22, 1918, by C. Boden Kloss.

*Material examined*.—Tay Ninh, Cochinchina (BM), one; Tay Ninh Mt., Cochinchina, 1000 meters (MNHN), one; Djiring, south Annam, 3500 feet (BM), three; Ban Me Thuot, Annam (CNHM), two; Langbian Peaks, south Annam (USNM), one.

*Discussion*.—This is a strikingly distinct subspecies with a small, poorly known range in southern Vietnam. The describers had examined nine specimens from three localities: Arbrey Broyé at 5400 feet elevation, Dalat at 4500 feet, and Dran at 3000 feet in the Langbian Mountains. It is notable that none of these localities, or of those from which we have examined material, is from below 3000 feet elevation, and that the greatest diameter of its known range barely exceeds 150 miles.

*Pelage color*.—The characters which distinguish it are: buffy tips, to as long as 15 mm., on the hairs of the back, producing about Light Ochraceous Buff in USNM No. 269797; the light tipping of the hairs intensifies to produce a distinct patch on the posterior part of the crown, about Light Buff in the same specimen; the pelage of the sides, limbs, and tail is black when the pelage is fresh. The buffy tipping extends onto the thighs and base of the tail to a small extent and sometimes onto the forelimbs. The black parts do fade to brown to some extent, particularly toward the tip of the tail. The color of the hair tips on the back varies, probably from fading and wear, but the molt line across the back of USNM 269797 shows very little color change from old pelage to new. Ventral pelage Antimony Yellow to Warm Buff, according to the describers, and bib, flash mark on fore legs, and frequently the hind feet, are the same color.

*Diagnosis*.—Closely related to *leucogenys*, particularly by the pale nape patch, but also by the flash mark on the fore leg and the hind foot color, *smithi* is nevertheless sharply distinguished from it by the light-tipped pelage running the length of its back. From *hainana*, *smithi* differs by possession of the flash mark on the fore legs and by lacking ear tufts.

*Dimensions*.—Kloss' measurements in millimeters of the type are: length of head and body, 415; length of tail, 500; length of hind foot, 89; length of ear, 31. The describers say that the skull of the largest

of nine specimens measured 79 and 50 mm. in greatest length and breadth of skull respectively.

### **Ratufa bicolor condorensis** (Kloss)

*Ratufa melanopepla condorensis* Kloss, 1920, Jour. Nat. Hist. Soc. Siam, 4, p. 71. (NOT *R. condurensis* Miller, 1907.)

*Type*.—C. Boden Kloss No. 2706 (not found by the present revisers), adult female from Main Island, Pulo Condore, off the coast of South Viet Nam (NOT Pulo Condur of the Malacca Straits).

This insular form shows close relationships to *leucogenys* and *smithi* in consistent possession of a light nape patch. It differs from both of these primarily in size, for *condorensis* is a pigmy giant squirrel, the skulls of seven specimens measuring 60, 61.5, 62, 62.5, 62.5, 63, 64 mm. A greatest skull length of *smithi* (Robinson and Kloss, 1922, p. 93) is 76 mm., and for three *leucogenys* is 71, 71, 73 mm. (Kloss, 1916, p. 69). This small insular form differs from *smithi* by lacking light tips to the pelage of the back, but otherwise resembles both *smithi* and *leucogenys* closely in pelage color.

No material representing this subspecies was examined during the present study. This subspecies is not shown on the map in Figure 4.

### **Ratufa bicolor felli** (Thomas and Wroughton)

*Ratufa felli* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 226.

*Type*.—BM No. 15.5.5.55, adult male from Yin, East bank of Lower Chindwin, Burma, collected June 13, 1914 by G. C. Shortridge.

*Material examined*, all from Burma.—Dudaw-Taung, 650 meters, Pakokku Chin Hills (AMNH), two; Ainggyi, Pakokku Chin Hills (AMNH), one; Mt. Victoria, 500 meters (AMNH), one; Yin, Lower Chindwin (BM), 4; Okma, east bank of Chindwin R., N. Burma (AMNH), two.

*Pelage color*.—This appears to be a well-marked subspecies with a small, and poorly known, geographic range. It differs from *gigantea* and *hainana* to the north by having no ear tufts, by having an invasion of buffy from the insides of the fore legs virtually across the dorsal surface, which is otherwise black, by having a more pronounced border of the ventral pelage. It shares with *hainana* a somewhat richer ventral pelage color than that of *gigantea*, and also the light mark on the side of the hind foot, and it shares with *peninsulae* to

the south, all of these characters. It differs from all of its conspecific geographic neighbors, however, in that its dorsal pelage from the shoulders to the rump and the pelage of its sides from the fore legs to the hind legs is pale even when fresh. This gives *felli* a general dorsal color pattern like that of *Ratufa bicolor palliata* of Sumatra: black on the head, nape, limbs, and tail, and light brown between the fore and hind quarters. In the present subspecies, however, the color of the sides is just like that of the back, not distinctly lighter as is the case in *palliata*. In one example of *felli* with apparently fresh glossy pelage the middle dorsal area is very close to but a little browner than Light Ochraceous Buff (XV), whereas in another it is about Cinnamon-Buff (XXIX). The head and limbs are about Blackish Brown (1) XLV, and the nape and rump are intermediate. The intermediate pale brown of the rump continues out the tail for about a decimeter in the two with fresh pelage. The ventral pelage is blackish at the bases of the hairs on the hind legs as well as on the body, and is tipped with Cream Color to Warm Buff on an individual. The bib and blaze on the fore leg is Cream Color.

It must be noted that the Mt. Victoria specimen is black dorsally like *gigantea*, but has no ear tufts, and is intermediate in the extent of the white blaze or flash mark across the fore leg, in having a small light mark on the side of the hind foot, and in the intensity of color of the ventral pelage. This specimen is either an intergrade between *felli* and *gigantea* or a challenge to the validity of *felli* as a subspecies. In view of the striking character of the *felli* material, we assume the former.

### ***Ratufa bicolor gigantea* (McClelland)**

*Sciurus giganteus* McClelland, 1839, Proc. Zool. Soc. London, 1839, p. 150.

*Sciurus macruroides* Hodgson, 1849, Jour. Asiatic Soc. Bengal, 18, p. 775.

*Ratufa gigantea lutrina* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 226.

*Types*.—*Sciurus giganteus*, BM No. 79.11.21.336, young adult from Upper Assam, India, collected by J. McClelland; *macruroides*, BM No. 43.1.12.76–77, adult cotypes from Nepal collected in 1830 and 1840 by Hodgson; *lutrina*, BM No. 15.5.5.52, old female from Tatkon, near Kindat, Upper Chindwin River, Burma, collected July 5, 1914 by G. C. Shortridge.

*Material examined*, from easternmost India.—Duragiri, 1600 feet, Garo Hills (BM), one; "Langting," 1500 feet, Cachar Hills (BM), two; Mokokchung, 4500 feet, Naga Hills (BM), one; "Naga Hills"



Assam (BM), three; "Lakhani," Naga Hills, Assam, 1000 feet (BM), one, (AMNH), one; Tura, Assam (AMNH), two, (CNHM), two; "Chang chang Pani," Assam, 900 feet (AMNH), two; Ukhrul, Manipur, 6000 feet (BM), 1; Nongpoh, Khasi Hills, Assam (AMNH), 1, (CNHM), one; "Nepal" (BM), three; Pemionchee, Sikkim, 7000 feet (BM), one; Matanga River, 2500 feet, N. Kamrup (BM), two; Pashok, 3500 feet, Darjeeling (BM), one; Chin Hills 35 miles west of Kindat, 1500 feet (BM), one; Sevoke, Bengal (CNHM), two; Sangsir, 1400-2000 feet, Bengal (CNHM), three, (USNM), two; Tarkhola, Sikkim (CNHM), two; Karong, Manipur (CNHM), one.

*Material examined*, from Tibet.—"Dening," 2250 feet, *Mishmi Hills* (BM), one; "Piki," *Mishmi Hills* 1440 feet (BM), one; "Drexli," *Mishmi Hills*, 5140 feet (BM), one.

*Material examined*, from Burma.—"Haingyan," 5000 feet, Chin Hills (BM), one; Hkamti, 500 feet, west bank upper Chindwin (BM), two; Kachin Hills 100 miles north of Myitkiyna, 1500 feet (BM), one; Mounkan, between Homalin and Tamanthe, east bank upper Chindwin River, 420 feet (BM), one; Lonkin (AMNH), one; Heinsun, west bank Chindwin R. (AMNH), one; Linhpah, west bank Chindwin R. (AMNH), one; Kindat (BM), one, (AMNH), one; Kabaw Valley, 20 miles west of Kindat, 600 feet (BM), one; Taukchaun, east bank of Chindwin, 500 feet (BM), one; Tatkon (BM), two; Road from Tamanthe to Sinnaing, west bank Chindwin R. (AMNH), one; Mounkan east bank Chindwin R. (AMNH), six; Hualung, east bank Chindwin R. (AMNH), two; 25 miles W. of Myitkyina (USNM), three; "Sedaw, Mandalay Canal and District," 300 feet (BM), one; Kamaing, Myitkyina Dist. (BM), one; N'bungku (AMNH), one; Haibum (AMNH), four; Pumsin (AMNH), one; Htingwan, 4000 feet (BM), two; Hkani, 3000 feet, Gaw (BM), one; Singkaling Hkamti (AMNH), three.

*Pelage color*.—From Nepal eastward across Sikkim, Assam, northern Burma, Yunnan, northern Thailand, and northern Indochina to Hainan the giant squirrel is characterized by tufted ears and entirely black dorsal pelage on the fore legs. In Assam and northern Burma we find that considerable American Museum of Natural History material shows the tips of the ventral body pelage to be rather consistently pale, ranging between Cartridge Buff (XXX) and Light Buff (XV) on an individual (judged in places where the dark gray of the hair bases is entirely hidden by the pale tips). At Maymyo, Wan Tien, and the Nam Ting River, however, the ventral pelage shows enrichment at least to Light Ochraceous Buff, and this is true

of the material from northern Thailand. This more intense color is here considered to be but a dilution of the still richer color characterizing the ventral pelage of the subspecies described from Hainan, which is consistently Apricot Buff to Ochraceous Orange on each Hainan individual.

Thomas (1923, pp. 85-86) has shown that in northern Thailand the giant squirrel has a little patch on the side of each (otherwise quite black) hind foot that is the color of the ventral pelage. He found that this character diminishes greatly in northern Burma and Assam, and is entirely absent in the Mishmi Hills, Sikkim, and Nepal. We note, however, that it continues strong from northern Thailand to the westward and characterizes the subspecies which had been already described from Hainan, and so is not diagnostic for the subspecies *stigmosa* which Thomas (*loc. cit.*) erected upon it in Thailand. We consider that this character like that of the rich color of the ventral pelage, may emanate from *Ratufa bicolor hainana*.

*Diagnosis.*—Consequently, *Ratufa bicolor gigantea* may be identified by presence of ear tufts, black dorsal pelage on the forelegs, pale ventral pelage (about Cartridge Buff to Light Buff), and scarcity of any buff pelage on the side of the hind foot. The Maymyo and Nam Ting River specimens are apparently intergrades with *hainana* to the southeast.

*Variation.*—Possibly there is a geographic race which should be recognized as *Ratufa bicolor lutrina*, occupying an area in northern Burma. However, the characters on which *lutrina* has been based are virtually identical with the faded condition of the pelage of some undoubted *gigantea* just prior to molt. If the brown color of *lutrina* were the color of the fresh pelage, and if it predominated in a geographic area, we would freely accord subspecies status to *lutrina* as have Zahn (1942), Carter (1943), and Ellerman and Morrison-Scott (1951). There could, of course, quite by chance be taken in a given area. A preponderance of specimens whose pelage had come in black when fresh but had faded to brown at the time of collection. There could also be a greater tendency in a geographic area for the pelage to fade quickly to brown, so that it is brown for a longer time before being shed and replaced by black. This quick change to brown could be effected by a special genetic factor or a special ecological factor or both in combination. Carter (1943) considered that this frequency of brown pelage was related to the animal's occurrence in the savannah forest, and he allocated the blacker specimens that he studied from the adjacent more heavily forested districts to the subspecies



*gigantea*. This necessitated arbitrary placing of a series from the deep forests of Lonkin and Singkaling Hkamti in *gigantea* even though the series is almost as brown as the alleged *lutrina*. Since there are small spots of new black pelage coming in in two of the brown specimens from Maunkan, the general brown color of the dorsal pelage of these "*lutrina*" is evidently produced by fading, and on the basis of the scanty information on its distribution now at hand, we give no credence to "*lutrina*" as a valid subspecies.

There is, further, some individual variation in pelage color within *gigantea* which should be mentioned. Near the base of the tail for about a quarter or a third of the tail length the short, appressed ventral hairs of the tail are usually buffy instead of black. In one specimen from Tura this buffy line extends for two-thirds the length of the tail. This specimen also has reddish subterminal color bands on the hairs of the dorsum and tail which contrast strongly enough with the basic blackish brown to be quite noticeable. Further, it has a splash of white-tipped hairs in the black dorsal pelage of each fore leg (about 15 mm. in diameter) and a whitish tipping to the hairs on one side of the hind foot. Another specimen from Tura has none of these variations from proper *gigantea* characteristics. A specimen from Nongpoh in the Khasi Hills is quite as brown as any of the alleged *lutrina*, and has even the pale tail tip. A specimen from "Changchang Pani," Assam, is richly colored enough ventrally and possessed of a strongly enough marked hind foot to be an intergrade with *hainana* were that geographically possible. One Hualung specimen from the east bank of the Chindwin River has almost whitish subterminal bands on many of the hairs of the dorsum, creating a rather agouti effect.

*Habits*.—In Sikkim collector C. A. Crump took 14 specimens at six localities and wrote these notes (Wroughton, 1916a, p. 486): "This squirrel is usually found in pairs and is not gregarious. It is more plentiful between the Terai and the low valleys up to 3,000 feet, being particularly partial to the dense tall jungle bordering rivers. It has a loud clacking note common to most squirrels but calls only on rare occasions. It is an extremely active climber and as a rule is wary, making off and hiding in the thick foliage immediately danger is feared."

*Dimensions*.—Collector H. Stevens noted weights of the three adult squirrels from Sangsir and Sevoke, Bengal Residency, India, on the specimen tags as four, four, and five pounds. These are all males taken in November and December, and are CNHM Nos.

35432, 35434, and 35437. This may be the giant squirrel's best claim to being the largest tree squirrel in the world. He found the female specimen from Tarkhola in the Teesta Valley of Sikkim to weigh  $4\frac{1}{2}$  pounds.

*Discussion.*—In January, 1931, Lord Cranbrook journeyed northwest from Putao, Burma, across the drainage of the Mali Hka to the Nmai Hka. While in the drainage of the former he heard (letter to us of May 5, 1961, based on his field notes) or saw giant squirrels daily. But once over the 6500 foot divide into the Nmai Hka Valley, he saw no more *Ratufa*; although "the vegetation and climate seem to be exactly the same on both sides of the divide." (Cranbrook, in Kinnear, 1934, p. 348.)

### ***Ratufa bicolor hainana* (J. A. Allen)**

*Ratufa gigantea hainana* J. A. Allen, 1906, Bull. Amer. Mus., 22, p. 472.

*Ratufa gigantea stigmata* Thomas, 1923, Jour. Bombay Nat. Hist. Soc., 29, p. 86.

*Types.*—*Ratufa g. hainana*, AMNH No. 26638, adult male from Cheteriang, Hainan, collected in 1903 or 1904 by agents of Alan Owstan; *stigmata*, BM No. 98.10.5.40, adult female from 730 meters on Doi Sritepe, Chiangmai, Siam, collected April 10, 1898, by T. H. Lyle.

*Material examined*, from Hainan.—Mt. Wuchi (AMNH), four, (BM), two; Nam Fong (AMNH), one; Mts. S. W. of Kachek (USNM), one.

*Material examined*, from Chinese mainland.—Wa-tien, Yunnan (AMNH), one; Wan Tien (MCZ), one; Shui-kow-kwan, Lungchow, Kwangsi (CNHM), one; Nam-ting River at Burma border, 1700 feet (AMNH), one.

*Material examined* from Indochina.—Bolovens Plateau, Laos (AMNH), two, (BM), one; Chapa, Tonkin (MCZ), two, (BM), two; 150 mi. west of Xieng Khouang, Laos (MCZ), one; Mt. Fansipan, Tonkin (MCZ), one; between Harsa and Lao Fou Thai, 3000 feet, Laos (CNHM), one; Muong Yo, 2300 feet, Laos (CNHM), two; Ban Phone (CNHM), two; Thateng (CNHM), two; Banteai (CNHM), one; Hoi Xuan, Annam (CNHM), one; Phong Saly, 4400 feet, Laos (CNHM), one; Tam Dao, 3000 feet, Tonkin (BM), five; Nape [Na Pe], 2500 feet, Laos (BM), three; Phu-Qui, 100 feet, Annam (BM), one, (MNHN), three; "Nghia-hung," Phu-Qui, 100 feet (BM), two; Xien Tuang-Koo [Xieng Khouang], Laos (BM), one; "Ci Nom," 1200 meters (MNHN), one.

*Material examined*, from Thailand.—Doi Sutep, Chiangmai (AMNH), one; Doi Pui, Chiangmai (AMNH), one; Doi Hua Mot (USNM), two; Doi Nangka (USNM), two; Doi Nangkeo (MCZ), two; Mt. Angka (MCZ), three; Ching Dao (MCZ), one.

*Material examined*, from Burma.—Maymyo (AMNH), one; Gokteik, 2133 feet, Northern Shan States (BM), one; Katha (BM), one; Madaya Forest, 55 miles north of Mandalay, 2000 feet (BM), two.

*Original description*.—"Whole upper parts, outsides of limbs, and the tail uniform intense black; ventral surface and inside of limbs rusty yellow, the basal half of the pelage over the chest and belly brownish black, showing more or less at the surface over the central part of the abdominal area; a broad black cheek stripe, and two small spots of black on chin. Ears tufted . . ." J. A. Allen gave this description from only the one type specimen, but it is quite good for the additional material subsequently available from Hainan reported here. From our inspection of the above material, however, his suggestion that the nasal bones of *hainana* are longer than those of *gigantea* is not sustained. For further discussion of the characters of *hainana*, see the account of *gigantea*.

*Habits*.—A collector and observer of this squirrel reports: "Plentiful in all big forests especially round Gokteik, quite identical in habits with [Indian] giant squirrels." (G. C. Shortridge in K. V. Ryley, 1914, p. 721.)

## INDIAN STRIPED SQUIRRELS

### Genus FUNAMBULUS Lesson

*Funambulus* Lesson, 1835, Illustr. de Zoologie, pl. 43, and 2 pp. of text.

*Palmista* Gray, 1867, Ann. Mag. Nat. Hist., (ser. 3), 20, p. 279.

*Tamiodes* Pocock, 1923, Proc. Zool. Soc. London, 1923, p. 215.

*Type species*.—*Funambulus*, *Sciurus indicus* Lesson (= *S. palmarum* Linnaeus); *Palmista*, fixed as *F. palmarum* Linnaeus by Thomas, 1897, Proc. Zool. Soc. London, 1897, p. 933; *Tamiodes*, *Sciurus tristriatus* Waterhouse.

*Definition*.—The genus *Funambulus* comprises the species *penanti*, *palmarum*, *tristriatus*, *layardi*, and *sublineatus*, all of which are small to medium-sized tree squirrels and endemic to the Indian Sub-region. (See their distributions in Figures 7–11.)

*Diagnosis*.—(1) The baculum of *Funambulus* is a single unit, lacking the separate bony blade characteristic of some squirrels (Pocock, 1923). (2) There is (as shown in the lateral views in Figures 5 and 6) no dorso-anterior process of the premaxillary bone rising to abut upon the anterolateral angle of the nasal bone (Moore, 1959, p. 170). (3) There are (as shown in the ventral views in Figures 5 and 6) one or two transverse bony septa crossing the auditory bulla (Moore, 1959, p. 170). (4) There are in parous females but two pairs of functional mammae (Moore, 1961a, p. 8). (5) The dorsal pelage is longitudinally striped with 3 or 5 light stripes contrasted with brown or black pelage between stripes. (6) The coronoid process of the mandible is low and only incipiently falcate. (Compare Figures 5 and 6 with Figures 1, 12, 17, 22, 23, 30, and 32.)

The above six characters distinguish *Funambulus* from other Sciurinae of the Indian and Indochinese subregions as follows: from *Ratufa* by 2, 3, 4, 5, and 6; *Callosciurus* by 1, 2, 5, and 6, *Tamioops* by 1, 2, 4, 5, and 6, *Dremomys* by 1, 2, 4, 5, and 6; *Menetes* by 1, 2, 4, and 5; and *Sciurotamias* by 2, 3, 4, 5, and 6.

*Systematic history*.—For many years the genera *Dremomys*, *Lariscus* and *Menetes* were confused with *Funambulus*. A number of forms belonging in those genera were described as forms of *Funam-*

TABLE 3. Dimensions in Millimeters of Type Specimens of the Genus *Funambulus*. (Nos. 1 to 3 represent the species *pennanti*; 4-11, species *palmarum*; 12-16, species *tristriatus*; 17, species *layardi*; 18-20, species *sublineatus*.)

	BODY				SKULL					
	Head & Body	Tail	Hind Foot	Total Length	Mas- toid Breadth	Length Nasals	Dia- stema	Palatal Length	Bullar Length	Molar Tooth Row
1. <i>pennanti</i>	156	156	40	37.9	16.6	11.3	7.6	18.2	7.9	6.2
2. <i>lutescens</i>	140	141	40.5	36.8	....	10.9	8.1	18.3	7.7	6.4
3. <i>argentescens</i>	133	146	41	37.4	16.0	11.4	8.6	18.9	8.4	6.2
4. <i>olympius</i>	154	126	40	39.3	16.0	12.1	8.9	20.3	7.3	7.2
5. <i>brodiei</i>	140±	80±	40±	....	17.0	....	8.9	18.6	7.1	6.5
6. <i>faronicus</i>	143	144	38	37.6	16.1	11.7	8.1	18.6	7.0	6.8
7. <i>matugamensis</i>	136 <sup>1</sup>	140	38±	37.8	15.8	10.9	9.0	18.4	7.2	6.8
8. <i>comorinus</i>	153	178	44	39.1	16.6	12.1	8.3	20.0	7.1	7.1
9. <i>gossei</i>	138	147	39	37.0	16.4	11.0	8.8	19.0	7.5	7.1
10. <i>bellarticus</i>	168 <sup>1</sup>	156	41	38.8	16.5	11.9	9.4	20.0	8.2	6.7
11. <i>robertsoni</i>	140	146	39	39.1	16.7	11.0	9.6	19.7	7.6	6.3
12. <i>tristriatus</i>	190±	130±	43±	....	....	13.5	10.8	23.0	...	7.8
13. <i>dussumieri</i>	170±	80±	42±	....	....	14.6	10.6	23.0	...	8.1
14. <i>wroughthoni</i>	195	172	46	47.3	18.4	15.3	11.5	26.0	8.2	8.7
15. <i>numarius</i>	155	135	40	41.8	17.3	12.6	10.0	21.6	7.6	7.1
16. <i>thomasi</i>	147	130	40	40.4	17.4	12.7	9.7	21.1	7.9	6.8
17. <i>signatus</i>	155	145	38	39.3	16.8	11.8	9.0	19.5	7.3	6.5
18. <i>sublineatus</i>	130±	100±	31±	....	....	9.9	7.4	16.9	...	5.5
19. <i>delesserti</i>	140±	100±	32±	....	....	....	7.6	17.0	...	5.6
20. <i>kathleenae</i>	125	122	35	37.0	15.2	10.7	8.3	19.0	6.3	6.8

<sup>1</sup>Measurement on specimen tag possibly in error.



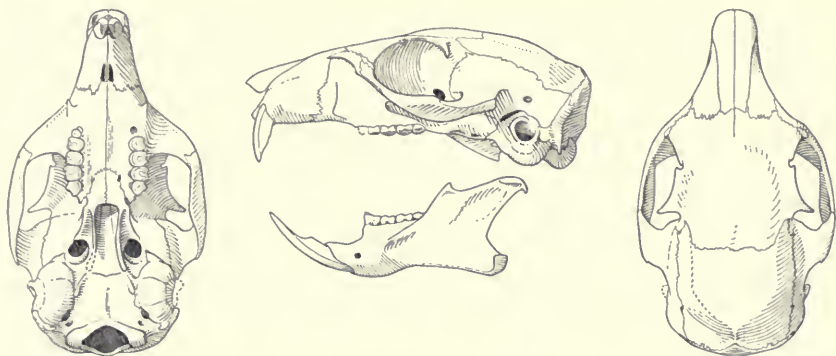


FIG. 5. Skull and left mandible of the Indian striped squirrel, genus *Funambulus*, species *tristriatus*, AMNH No. 54652,  $\times 1$ . Note that there is no dorso-anterior process of the premaxillary bone rising to abut evenly with the antero-lateral angle of the nasal bone as is present in all other genera of Oriental squirrels.

*bulus*. The relationship was clarified when Thomas (1908, 1914, 1916a) separated *Lariscus* and "*Zetis*" (= *Menetes*) from *Funambulus* of the Indian peninsula and Ceylon. This distinction was further emphasized by the marked differences in the bacula discovered by Pocock (1923), whose consequent placement of these genera in separate subfamilies was recognized by Simpson (1945) as of tribal difference. Prasad (1951, 1954, 1957) discovered that the male reproductive tract of *Funambulus* is of a non-penile-duct type, extremely different from the type considered characteristic for *Sciuridae*, and (1957, p. 21) proposed that this genus be separately raised to subfamily rank. Moore (1959, p. 170) found a skull character which links *Funambulus* with African genera *Funisciurus*, *Paraxerus*, and *Myosciurus*, the male genital tracts of which are not known, and left these four genera all in the tribe *Funambulini* Simpson.

Early systematic treatments of the genus *Funambulus* are few: Blyth (1849, 1852) dealt with Ceylonese races. Wroughton (1905) discussed the identity of *F. palmarum* at length and distinguished it from the north Indian *F. pennanti*. Thomas and Wroughton (1915b) published a key to the *Funambulus* of Ceylon. Wroughton (1916d) worked out the races of the species *palmarum* and *tristriatus* of peninsular India. Pocock (1923) showed the characters of the glans penis and baculum in *F. palmarum* and *F. tristriatus* and solely on the differences in these separated the species *tristriatus* at the generic level as *Tamiodes*. Phillips (1928) discussed the vari-

ous *Funambulus* from Ceylon. W. C. O. Hill (1936) examined the bacula of all Ceylonese *Funambulus*, and was puzzled to find that the bacula of all the Ceylonese forms thought to belong to species *Funambulus palmarum* actually display the characters which Pocock (1923) ascribed to *Tamiodes tristriatus* and differ, just as *tristriatus* was supposed to differ, from Pocock's (1923) characterization of *F. palmarum*. Prasad (1957, p. 7) supports Hill's findings with an excellent figure showing the baculum of Ceylonese *F. palmarum kelaarti* to be like that of *tristriatus*, also. Furthermore, Prasad (1954, fig. 2) had already shown that the baculum of *F. palmarum palmarum* of India was also quite a good deal more like Pocock's figure of *tristriatus* than like Pocock's *palmarum*. It remains only, then, to note that Prasad's (1957, fig. 2) illustration of the baculum of *Funambulus pennanti* of northern India is like Pocock's (1923, fig. 20) of *F. palmarum*. Pocock's specimen alleged to be *palmarum* was therefore evidently *pennanti*. Actually, as Hill (1936) and Prasad (1954, 1957) have now shown, the bacula of *Funambulus palmarum* indicate close relationship to *F. tristriatus*, and it is *F. pennanti* which is very different. This solution to the *Tamiodes* puzzle is almost equally well established by the close correspondence of the characters described by Pocock (1923, p. 215) for the glans penes of his supposed *Funambulus palmarum* and *Tamiodes tristriatus* respectively to the illustrations of *F. pennanti* (Prasad, 1957, fig. 1) and *F. palmarum* (Prasad, 1954, fig. 2). Furthermore, since no one has yet published a description or figure confirming the male genital characters of *tristriatus*, it remains possible that Pocock's (1923) *tristriatus* was in fact a specimen of *palmarum* and that male genital characters for *tristriatus* remain unknown.<sup>1</sup>

Pocock's mistake with *pennanti* must be a fairly easy one to make, for Didier (1953, p. 69, fig. 3) has evidently made it again, illustrating in detail three views of the baculum of "*Funambulus palmarum* L. (Hindustan)." The figures quite evidently represent the baculum which Prasad (1957) has shown to be that of *pennanti*.

Zahn's (1942) revision of this genus is distinguished particularly by his inclusion in it of the striped squirrels of the subgenus *Tamiops*. Ellerman and Morrison-Scott (1951) did not follow this superficial arrangement, and Moore (1959, 1961a) has produced new evidence

<sup>1</sup> Recognition now of the nature of the error involved in Pocock's concept of *tristriatus* as a distinct genus justifies earlier abandonment of this concept by various authors because of Hill's (1936) evidence of its incongruity. The difference recognized by Pocock (1923) still exists, differentiating *pennanti* (not *tristriatus*) from the other four species, and will be honored here as of subgeneric significance.

that supports Pocock's (1923) in classifying *Funambulus* with certain African squirrels in the tribe Funambulini but *Tamiops* with Oriental genera in the tribe Callosciurini. Further evidence is also offered in the present paper in the discussion under *Tamiops*.

Parameters of the populations of subspecies of the genus *Funambulus* as represented by museum material would be an important contribution to knowledge, although it is too intensive for so extensive a revision as the present one. Some indication of the variation in size within the genus, however, may be seen in Table 3. The sample representing species *palmarum* in Table 3 may give a fair indication of where the mean for any of these measurements in that species might fall.

*Distribution*.—This primarily tropical genus inhabits India and Ceylon. Three of its five species are represented by seven forms on Ceylon. Nine other races representing all five species, appear to occur on the mainland only below the Tropic of Cancer, leaving five races (representing only two species) which occur north of it.

*Intragenetic relationships*.—The constancy of the distinctive striped pelage pattern causes the species of *Funambulus* to seem extremely close in relationship to one another. The most distinct of the five species is *pennanti*, for not only does it possess five white stripes instead of the three common to the other four species, but its rod-like baculum lacks any suggestion of the bifurcated tip now reported to occur in the other four species, and the shape of its glans penis apparently also differs from that of the other four (Hill, 1936, figs. 1–5; Prasad, 1954, fig. 2; Prasad, 1957, fig. 1).

One might anticipate finding an interesting amount of difference between the two species of jungle squirrels, *sublineatus* and *layardi*, which occur in heavy jungle in southern India and Ceylon. Their glans penes and bacula as illustrated by Hill (1936, figs. 4 and 5) appear to distinguish the two from each other as much as from *palmarum*. From a very meager amount of material, one skull of *F. s. sublineatus*, UMMZ No. 81078, three of *F. s. obscurus*, MCZ No. 27550, NMC No. 60-x-E, NMC No. 60-x-C, and two of *Funambulus l. layardi*, NMC No. 59-H, and NMC No. 59-N, and a series of three photographic views each of the types of *kathleenae* (= *S. s. obscurus*), *sublineatus*, *delesserti* (= *sublineatus*), and *F. layardi signatus*, before the senior author, it appears that the interorbital breadth just behind the supra-orbital notches (to avoid a broken place), is 0.81, 0.84, and 0.85 of the greatest length of frontals in the three *layardi* and is 0.60, 0.63, and 0.68 in three of the *sublineatus*. If this difference is

constant, it is a large one, and suggests an important difference in ecological niche. The broad frontals with more lateral orientation of the eyes generally characterizes squirrels whose habits take them high in the trees. Narrower frontals and more upward orientation of the eyes characterize the species which are adjusted to living close to, or on, the ground. Since one would expect some niche difference between two closely related squirrels of the same genus which are said to inhabit the same jungles and which differ in size, it is especially interesting to find that Phillips (1935, pp. 238 and 241) reports *layardi* to inhabit the tops of the tallest trees in the tallest and heaviest forests, but *sublineatus* to inhabit the "undergrowth in the jungle." See details quoted in species account below of *sublineatus*.

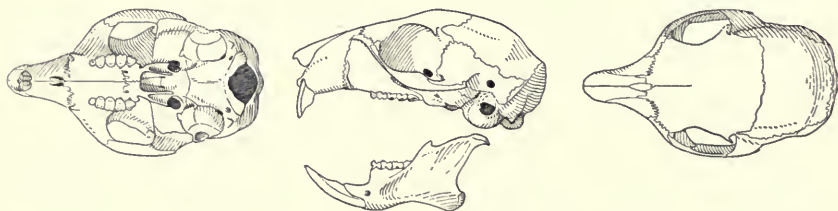


FIG. 6. Skull and left mandible of the Indian striped squirrel genus *Funambulus*, species *sublineatus*, UMMZ No. 81078,  $\times 1$ . Note the character that distinguishes *Funambulus* from all other Oriental squirrels, absence of any dorso-anterior process of the premaxillary bone rising to abut evenly with the antero-lateral angle of the nasal bone. Note also the characters that have led to *sublineatus* being considered an incipient pygmy squirrel (Moore, 1959, pp. 186-190).

Charles McCann (letter of June 21, 1961) comments on apparent ecological segregation of species on the mainland nearby: "... [near] the Palni Mountains *pennanti* is found on the plains, *palmarum* on the hills up to about 4,500 feet, and above occurs the little *F. sublineatus* feeding chiefly on *Rubus* species in the undergrowth, its normal habitat. The green viper, *Trimersurus macrolepis*, appears to be its natural enemy up to 7000 feet." (This locality, latitude  $10^{\circ} 20' N.$ , is about  $5^{\circ}$  farther south than the southernmost locality from which we have examined *pennanti* material.)

A further aspect of the same species character which distinguishes the above-mentioned available material of *sublineatus* from *layardi* (and also from *palmarum*, *pennanti*, and *tristriatus*) is obsolescence in *sublineatus* of the supra-orbital notch, which otherwise seems to be well developed throughout the genus.



The material on *Funambulus* in American museums and hence available to Moore in the present study, has been extremely small for the assessment of the validity of subspecies and to a much lesser extent than for other genera has it been possible to push the study beyond Tate's review concept to a revision.

Moore (1960) has pointed out that the squirrels confronting *Funambulus pennanti* across the Garo-Rajmahal Gap are tribally different, and that much zoogeographic importance may attach to detailed further field study of the distribution of *F. pennanti* and *Callosciurus pygerythrus* in this region, and where the two also appear almost to meet along the foothills of the Himalayas. See also a note in the account of *C. pygerythrus blythi* in the present paper. The importance and need of more data on the breeding of *F. pennanti* has also been shown (Moore, 1961, pp. 21, 27, 29).

#### KEY TO THE SPECIES OF *FUNAMBULUS*

1. Dorsal pelage marked by five longitudinal light stripes, and baculum a simple, slightly curved rod.....*pennanti*  
 Dorsal pelage marked by three longitudinal light stripes, and baculum bifurcated at distal end.....2
2. Fur long, tending to obscure the pelage stripes, supraorbital notches absent or obsolescent, bifurcations of baculum ending in large knobs.....*sublineatus*  
 Fur short, stripes quite distinct, supraorbital notches usually well developed; bifurcations of baculum without large terminal knobs.....3
3. Midstripe, at least, rather brightly colored (orange-yellow, etc.), ventral pelage richly colored (russet, chestnut, yellow-orange, etc.), bifurcation of baculum obsolescent (or only incipient?).....*layardi*  
 Midstripe and ventral pelage only pale buffy, bifurcation of baculum quite distinct.....4
4. Occipitonasal length usually exceeding 40 mm.; length of palate (front of incisors to back of palate) usually exceeding half of the occipitonasal length.....*tristriatus*  
 Occipitonasal length usually less than 40 mm.; length of palate usually less than half of occipitonasal length.....*palmarum*

#### PRASADSCIURUS new subgenus

*Definition.*—This subgenus includes only the species *Funambulus pennanti* Wroughton which is endemic to the northern part of the Indian Subregion. See its range as plotted from material we examined in Figure 7.

*Diagnosis.*—The baculum is an attenuate rod without apical bifurcation. The glans penis is extended apically in a slender point. There are five longitudinal light stripes in the pelage of the dorsum and sides.



*Funambulus pennanti* Wroughton is the type species. The subgeneric name recognizes the work of the Indian scientist, Dr. M. R. N. Prasad, whose description of the genital characters of *pennanti* provides the critical clue to clarification of the *Tamiodes* puzzle.

### **Funambulus pennanti** Wroughton

*Definition.*—This species includes all of the five-striped forms of *Funambulus* and is endemic to the northern part of the Indian Sub-region, most of its range lying north of the Tropic of Cancer. See Figure 7.

*Diagnosis.*—Same as for subgenus *Prasadscurius*. The following characters seem also to have diagnostic value in the material at the American Museum of Natural History. The longer pair of lateral stripes extends posteriorly over the rump to the base of the tail, and clearly forward upon the shoulders and nape to reach the ear. The middle stripe extends posteriorly onto the tail. The head of *pennanti* bears two nearly parallel stripes, a faint light stripe from ear to eye, and a stronger, almost white one from beneath the base of the ear forward below the eye, and sometimes quite clearly halfway out to the tip of the snout from the eye. This species possesses no bright, warm color about the anus or extending out the ventral side of the tail.

*Relationships to other species.*—In describing this species, Wroughton (1905) remarked, "It would almost seem that *palmarum* is a South and *pennanti* a North Indian form . . . they occur together on the West Coast. . . ." Our investigation certainly supports this early concept of distribution of the two species. See Figures 7 and 8. Only *F. palmarum robertsoni* and *F. p. bengalensis* occur within the range of *F. pennanti*, and except for a southward invasion just east of the Western Ghats to Dharwar (latitude 15° 27' N.), the species *pennanti* seems to range only north of the twentieth parallel of latitude.

A collector (C. A. Crump in Wroughton, 1915c, p. 108) reports observations on this species: "Common at Chainpur and well distributed throughout Hazaribagh where, however, it overlaps with *F. palmarum*, the latter I think predominating. At several places I shot both these squirrels on the same ground but did not find them together in any one tree." Separately one of us has treated the known interrelationships of these two species in more detail (Moore, 1960, p. 6) and speculated on their origin as species (pp. 9–12).

Mr. Charles McCann of the Dominion Museum, Wellington, N. Z., contributes (letter, June, 1961) the following comments on *pennanti* from his years in India with the Bombay Natural History Society:

"*Habitat*.—An inhabitant of the open plains and scrub country. It is more commensurate with man and is frequently associated with villages, whether on the Deccan Plain or the Sind Desert. Does not occur in jungle country except, perhaps, on the outskirts.

"*Coat*.—Harsher, smoother, and lying more flat than in *palmarum*.



FIG. 7. Geographical distribution of the five-striped Indian squirrel, *Funambulus pennanti*, as revealed by specimens examined, except that one record of *argentescens* is about 275 miles off the map at Mand, Baluchistan. Subspecies: A, *pennanti*; B, *argentescens*; C, *lutescens*.

"Voice.—Whistle-like, shriller, sharper and more prolonged than that of *palmarum*.

"Nest.—Builds nest under tiles and eaves of buildings and in hollow trunks of trees and among palm leaf sheaths. In the desert, owing to the absence of suitable nesting sites, it builds like *palmarum*, but the nest is globular and more disorderly. It will sometimes commandeer the nest of *Uroloncha*. Coconut fibre is in great demand when available—hence, its nest-building is destructive to mattresses placed out for airing.

"Habit.—More terrestrial than *palmarum*. Perhaps more omnivorous than *palmarum*."

### ***Funambulus pennanti pennanti* Wroughton**

*Funambulus pennanti* Wroughton, 1905, Jour. Bombay Nat. Hist. Soc., 16, p. 411.

*Type*.—BM No. 98.4.2.25, adult female from Mandvi Taluka, Bundha, Surat District, India, collected February 27, 1898, by R. C. Wroughton.

*Material examined*, from Bombay.—Bombay (BM), three; Shendurni, 900 feet (BM), one; Poona, 1900 feet, Deccan (BM), five; Karad, Satara District (BM), one; Nasith [Nasik] (BM), one; "Mehda," Satara District (BM), one; "Satapur." 20 feet, *Dhrangadhra* (BM), four; Dharwar, South Mahratta (BM), one; Bodbad [Bodvad], 1000 feet (BM), one; Parola, 880 feet (BM) two.

*Material examined*, from Berar.—Akola (UMMZ), one.

*Material examined*, from Central Provinces.—Balaghat District (CNHM), three; "Phichpalli," 1300 feet, *Chanda* (BM), two; "Thain," 1400 feet, *Hoshangabad* (BM), two; "Ganoor," 1000 feet, *Nimar* (BM), one; "Sakot," 1200 feet, *Hoshangabad* (BM), one; "Hewra," 1000 feet, *Nimar* (BM), two; Sohajpur, 1000 feet, *Hoshangabad* (BM), one; Chanda, 800 feet (BM), two; "Rithi, C. P." (AMNH), one; Khandwa (AMNH), two; Raipur (AMNH), five; Asirgarh, 1500 feet, *Nimar* (BM), one.

*Material examined*, from Gujerat.—Danta, 1000 feet (BM), one.

*Material examined*, from Kathiawar.—Junagadh [Junagarh], 480 feet (BM), two; Rajkot, 100 feet (BM), two; "Sadla," 10 feet, *Bajana State* (BM), two; Sehore [Sihor], 1600 feet, Bhaonagar Province (BM), four; Talala [Talaja], 200 feet, Junagarh State (BM), two; Van Kaneer [Vankaner], 500 feet (BM), three.

*Material examined*, from Sind, West Pakistan.—“Pano Agil,” Upper Sind (BM), five; Shikarpore [Shikarpur] (BM), one; Sehwan (BM), one.

*Material examined*, from Rajputana.—Mt. Abu, 4300 feet (BM), one; Sambhar (BM), one.

*Material examined*, from Punjab.—“Azadpur,” 550 feet, Delhi (BM), one; Lahore (UMMZ), one; Sirsa, Hissar (UMMZ), five; “Bhadwar,” Kangra (UMMZ), three; “Khajjean” Kangra (UMMZ), two.

*Material examined*, from United Provinces.—Pilibhit, 800 feet, Rohilkand (BM), two; “Dela,” 1500 feet, Ramnagar, Kumaon (BM), one; “Dachawri,” 2500 feet, Kumaon (BM), one; “Jerna,” 1500 feet, Ramnagar (BM), one; Ramnagar, 1100 feet, Kumaon (BM), seven; Siwalik Hills (BM), one; Etawah (UMMZ), two.

*Material examined*, from Gwalior.—Bhind (BM), three; Corepura [Chorepura], 1100 feet (BM), two; “Ghatigoan,” 900 feet (BM), four; Morar (BM), one.

*Material examined*, from Nepal.—Tribeni [Ghat], Terai (BM), four; Hetora [Hataura] (AMNH), one; “Pili,” Sipora or Sipna [Sipra] Valley (BM), one; “Bandasa,” West Terai (BM), two.

*Material examined*, from Bihar.—“Jagodih,” 600 feet, Hadari-dagh [Hazaribagh] (BM), two; Daltonganaj, 600 feet (BM), one.

*Material examined*, from Bengal, East Pakistan.—Chandpara (AMNH), three; Salbani, 200 feet, Midnapore (BM), two; Sevoke (CNHM), one; Kharagpur (UMMZ), one.

*Material examined*, from Cooch Behar.—Haldibari (MCZ), one.

*Original description*.—“. . . body colouring is very much as in *palmarum*, *comorinus*, but along the outside edge of the ‘saddle mark’ on each side there is a supplementary pale stripe . . . bounded on the outer side by the general body colour . . . where it is commencing to pale down to the meeting line with the belly colour. . . . No band of short, rufous hairs along the midrib under the tail as there is in *palmarum*. . . .”

### ***Funambulus pennanti lutescens* (Wroughton)**

*Funambulus lutescens* Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 429.

*Type*.—BM No. 13.9.18.105, adult female from Deesa, 450 feet, Palanpur, Gugerat, India, collected April 29, 1913, by C. A. Crump.

*Original description*.—" . . . rather smaller than true *pennanti*, about the size of *argentescens*, but much paler than either of these two forms. . . . General colour above pale 'cream buff' on the flanks, the saddle near 'mars brown' . . . the five longitudinal stripes white, very slightly tinged with buff, the lateral pair scarcely distinguishable. . . . Face drab. Hands and feet buffy white. . . . Below white, the hairs white to their bases. Tail also pale buffy white, each hair with two black rings. . . .

"This form ranges south as far as the northern part of Kathiawar, but thereafter the specimens grow darker . . . and show a passage to true *pennanti*."

In *lutescens* the lateral stripe runs undiminished from the ear to the hind limb; its width 6 mm.

### ***Funambulus pennanti argentescens* Wroughton**

*Funambulus pennanti argentescens* Wroughton, 1905, Jour. Bombay Nat. Hist. Soc., 16, p. 412.

*Type*.—BM No. 5.4.2.3, adult male from Rawalpindi, 1670 feet, Punjab, Pakistan, collected December 10, 1900, by Birrell.

*Material examined*.—Mand, Baluchistan (BM), one; Gajar, 3200 feet, Mashkai, Kalat (BM), two; Bohara [Bahara], Sind (BM), one; Garo [Gharo], Sind (BM), one; Jacobabad, Sind (BM), two; Kashmir, North Sind (BM), two; Mirpur Sakro, Sind (BM), three; Jhimpir Lake, Sind (UMMZ), two; "Khinjar Lake," Sind (UMMZ), three; Karachi, Sind (AMNH), one; Kohat, 1700 feet, North West Frontier Province (BM), three; Peshawar, 1700 feet (BM), two; Amballa [Ambala], Punjab (MCZ), six, (BM), one; "Ara," 2100 feet, Salt Range (BM), two; "Choan," 2400 feet, Salt Range (BM), one; Kallak Kahar [Kallar Kahar], 2113 feet, Salt Range (BM), two; Multan, 600 feet (BM), four; Rawal Pindi [Rawalpindi], 1671 feet (BM), 10; "Kotla," Kangra District (AMNH), six; Sodhi, 2000 feet, Salt Range (BM), one; Gholam (BM), one; Turbat, 600 feet, Kech (BM), three; Malasa, United Provinces (AMNH), one; "Larkanat," Naundero [Nandero] (BM), two; Kooloo Valley [Kulu Valley] (MCZ), two; Chak-Lala [Chakwal] 1100 feet, Rawalpindi, N. W. Punjab (CNHM), two.

*Original description*.—" . . . Pattern . . . identical . . . with . . . *pennanti* . . . much paler, however, and almost all rufous tint has disappeared, . . . body colour is a pale French Gray . . . stripes and belly bright white. . . ."



The pelage is very short. The three white dorsal stripes are each 5 mm. wide. Dorsal pelage is dark reddish brown, grizzled, becoming pale gray on the shoulders, neck, and head. The limbs are pale gray. Ventral pelage is white the full length of the hairs.

This subspecies is distinguished from *F. pennanti pennanti* by whiter tail, paler feet (Pale Olive Buff), and paler body color. That the races of *F. pennanti* can apparently be distinguished by the number of black bands on the tail hairs was noted too late for testing on all the material examined, but we find that it separates the above five lots of *p. pennanti* from the two of *p. argentescens* of the AMNH material; two bands in *p. pennanti*, one in *p. argentescens*.

### **Funambulus palmarum** (Linnaeus)

*Definition.*—This species includes those three-striped squirrels of the Indian Subregion, distributions of which are shown by collecting localities for the specimens we have examined, in Figure 8. (See also the synonyms listed in the subspecies accounts.)

*Diagnosis.*—(1) The baculum is distally bifurcated or makes a right angle turn near the distal end, but the apex or apices are not knobbed. (2) The dorsal pelage is marked by three very distinct longitudinal light stripes. (3) The occipitonasal length is usually less than 40 mm. (4) Measurement from front of incisor to back of palate is usually less than half the occipitonasal length. (5) The pelage is relatively short and harsh. (6) The midstripe and ventral pelage are no more richly colored than pale buffy.

The above characters distinguish *palmarum* from the other congeneric species as follows: *pennanti* by 1 and 2; *tristriatus* by 3 and 4; *layardi* by 6; and *sublineatus* by 1, 2, and 5.

*Relationship to other species.*—Mr. Charles McCann of the Dominion Museum, Wellington, N. Z., contributes the following remarks (letter of June, 1961) on *F. palmarum* from his years with the Bombay Natural History Society in India:

*Habitat.*—More a hill forest species than is *pennanti*, inhabiting deciduous rain forest. Ascends to about 4,000–4,500 ft. In such localities it will approach human environments, taking the place of *pennanti*. On the Panchgani-Mahabaleshwar plateau, 4100 ft., (outskirts of the Western Ghats), *palmarum* occurs on the hills, but is replaced by *pennanti* on the Deccan Plain (=1800 ft.). *F. palmarum* occurs almost throughout the Western Ghats in deciduous rain forest but does not enter the wet evergreen forest.

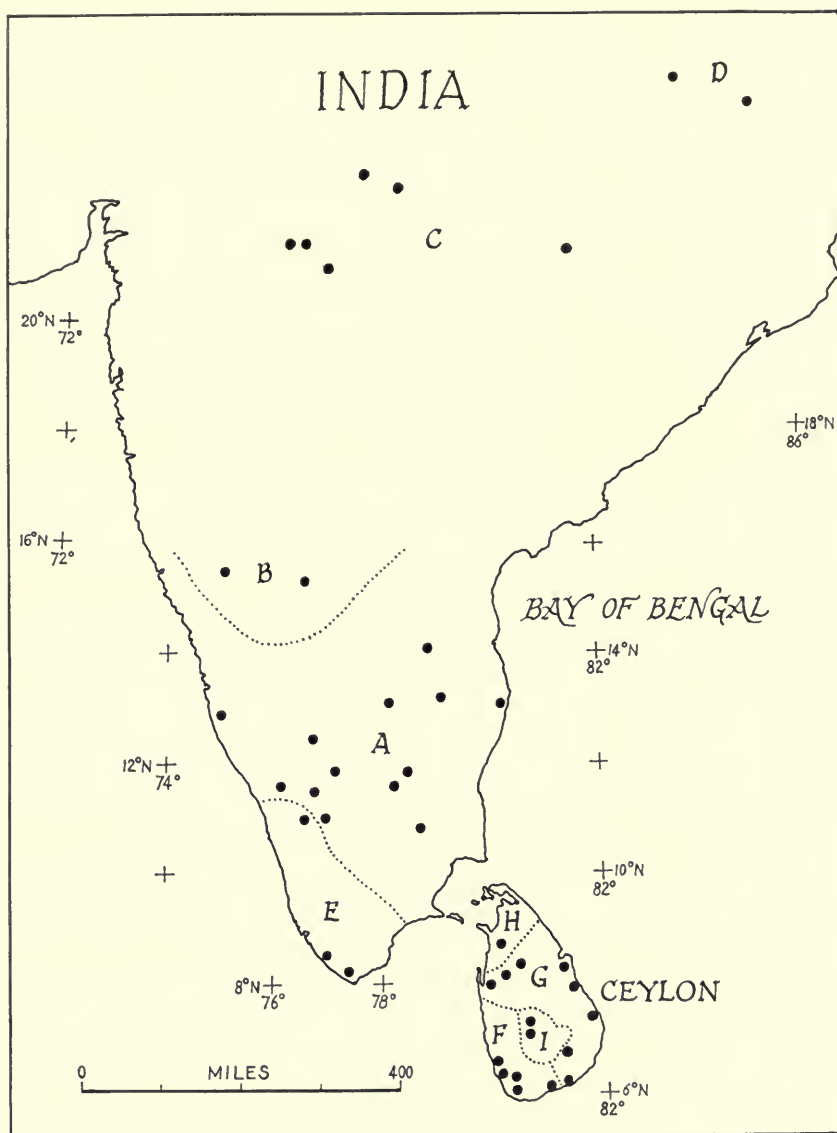


FIG. 8. Species range of the Indian palm squirrel, *Funambulus palmarum*, as shown by specimens examined. Subspecies: A, *palmarum*; B, *bellaricus*; C, *robertsoni*; D, *bengalensis*; E, *comorinus*; F, *favonicus*; G, *kelaarti*; H, *brodiei*, and I, *olympius*. The combined ranges of species *palmarum* and *pennanti* approximate the extent of the Indian Subregion.

"Coat.—Soft and somewhat silky and in life more erect than that of *pennanti*.

"Voice.—More bird-like and slightly deeper than that of *pennanti*.

"Nest.—Builds nest like a passerine bird in branches, somewhat globular.

"Habit.—More arboreal but does come down to the ground. Nectar is one of its foods. Bark searching is a frequent habit, possibly for insects. Fruit appears to be its main diet."

### ***Funambulus palmarum palmarum* (Linnaeus)**

*Sciurus palmarum* Linnaeus, 1766, *Systema Naturae*, 12th ed., 1, p. 86.

*Sciurus penicillatus* Leach, 1814, *Zool. Misc.*, 1, p. 6, pl. 1.

*Sciurus indicus* Lesson, 1835, *Illustr. de Zoologie*, no. 15, pl. 43, 2 pp. text.

*Funambulus gossei* Wroughton and Davidson, 1919, *Jour. Bombay Nat. Hist. Soc.*, 26, p. 730.

*Types*.—*Sciurus palmarum*, apparently lost, not found at Upsala, locality restricted to vicinity of Madras, India (Wroughton, 1905, p. 410); *penicillatus*, not found; *indicus*, not found; *gossei* (BM) No. 19.6.2.30, an adult male from Kotagiri, 4100–4500 feet, Nilgiri Hills, taken June 20, 1918, by Philip Gosse.

*Material examined*, from Madras Province.—"Adyar" [in city of Madras] (BM), two; "Kilcauk" [Kilpauk in city of Madras] (BM), two; "Museum Grounds" [city of] Madras (BM), two; "Panampet" (BM), one; "Tadiarpet" (BM), one; Trichinopoli, 400 feet (BM), two; Chittoor (AMNH), one; Salem District (AMNH), two.

*Material examined*, from other provinces.—Coimbatore (BM), one, (CNHM), one; Polkonda Hills, 1000 feet, S. Cuddapah (BM), two; Shevaroy Hills, 4500 feet, E. Ghats (BM), one; "Sweat Dist." (BM), one; "Machen," 4000 feet (BM), one; Kanara at S. Mahratta border, 2000 feet (BM), one; Seringapatam, 2338 feet, S. Mysore (BM), three; Kolar, 2786–4026 feet, E. Mysore (BM), two; Kurumdapatti, Salem Distr. (BM), three; Kalhatti [*Kalpatta*], Nilgiri Hills (AMNH), one; "Kellengode" (AMNH), one; "Honnametti Estate," *Biligirirangan Hills*, Mysore (AMNH), one; Anaikatti, Nilgiri Hills (AMNH), one; "Gantha," 1300 feet, *Coimbatore*, southern India (BM), one; "Rookery Kil," 4500 feet, *Kotagiri*, Nilgiris (BM), three.

Although *gossei* was originally described as belonging to the "*tristriatus* group," Ellerman (1940, p. 379) held it a separate species by itself, and Zahn (1942, p. 58) placed it in the species *palmarum*.

Comparison of the dimensions of the type of *gossei* in our Table 3 with those of species *palmarum* and species *tristriatus* supports Zahn's allocation. Ellerman and Morrison-Scott (1951, p. 494) synonymize *gossei* under *F. p. palmarum*, and this seems to us the most reasonable treatment.

The color of *F. p. palmarum*, as evidenced by the above series of three from the Salem District and Chittoor near the type locality: A middorsal area Mummy Brown to Prout's Brown pales anteriorly behind the shoulders and posteriorly on the rump. Through this run three longitudinal lines of Light Buff to Light Ochraceous Buff about 3 to 4 mm. wide. The middle one of these extends from the nape (into which it may extend faintly) to the base of the tail. The lateral ones separated by 11 to 12 mm. from the middle stripe, extend from back of the shoulders onto the rump, failing to match the length of the middle stripe by about 10 mm. anteriorly and perhaps 3 to 5 mm. posteriorly. Five to 7 mm. below the lateral lines, the Mummy Brown dorsal area changes abruptly to the agouti sides, which are Smoke Gray to Apricot Buff. The color of the sides extends onto the shoulders, nape, cheeks, ears, and rostrum, and onto the flanks and all limbs and feet. The crown color is intermediate between that of the sides and back. There is an almost white area about 2 by 10 mm. just medial to each ear, oriented anteroposteriorly, and fading into the body color posteriorly. There is a light-colored "eye-ring" 1 mm. wide above and below the eye, but not enclosing it at either end. The tail is somewhat less than half the animal's total length, about 20 mm. wide. Its dorsal and lateral hairs are whitish at the base, middle, and tip, with two black bands between and these give the tail as a whole an appearance of jumbled annulation (with about 15 black rings in one instance). On the hairs of the lower surface of the tail the basal and middle portions of each hair are Cinnamon-Rufous proximally on the tail grading out to Apricot Buff at its end. This Cinnamon-Rufous color extends onto the ventral pelage of the body in a small area about the anus. The ventral pelage from this to the chin and on the under sides of all the legs is white with faint washings of Maize Yellow.

*Habits.*—G. C. Shortridge remarks of *Funambulus palmarum* collected in the vicinity of Dharwar (in Wroughton, 1912, p. 1186), "They may often be found in prickly pear thickets when their mouths are usually stained crimson with the juice of the fruit. Both this species and *tristriatus* feed also on the berries of the *Lantana*."



**Funambulus palmarum comorinus** Wroughton

*Funambulus palmarum comorinus* Wroughton, 1905, Jour. Bombay Nat. Hist. Soc., 16, p. 411.

*Type*.—BM No. 95.10.9.10, adult female from Katyani, Trevandrum, Travancore, India, collected January 23, 1895, by H. Ferguson.

*Material examined*.—Nagercoil (BM); one, "Benhope," 3000–4000 feet, Nilgiris (BM), three; Kotagiri, Nilgiris (BM), two; Trevandrum, Trevancore [Travancore] (BM), 11.

*Original description*.—"Differs from [*palmarum*] by its much soberer grey colouration and larger skull measurements."

This race, generally much darker in color than the true *palmarum*, is evidently closely related to the dark races of Ceylon. The width of the median line is between 2 and 3 mm. The brown of the dorsal colored area between each lateral line is considerably narrower than in other races of *palmarum*. The hairs of the under parts are white or dirty white, with short gray bases. The anal area is brown, as in other Indian forms.

**Funambulus palmarum bellaricus** Wroughton

*Funambulus palmarum bellaricus* Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 647.

*Type*.—BM No. 13.4.10.39, adult male from Vizayanajar, Bellary, India, collected July 20, 1912, by G. C. Shortridge.

*Material examined*.—Vizayanajar, 1500 feet, Bellary, India (CN-HM), two.

*Original description*.—" . . . differs [from *palmarum*] in the complete absence of yellow suffusion on the forearms, shoulders, and thighs. General colour above rather a coarse grizzle of black and white, giving the effect of pale 'smoke grey.' The whole dorsal area forming 'a saddle,' which is coloured much darker. . . . The usual three longitudinal dorsal stripes creamy white. The face more or less suffused with ochraceous, according to season. Feet and hands pale. . . . Tail black and white, very indistinctly barred, and below 'orange rufous.'

"Shortridge obtained . . . 29 specimens in s. Mysore . . . considered intermediates [between *bellaricus* and *palmarum*]."

This subspecies is sharply separated from subspecies *palmarum* by the much greater width of the white median line, 6 mm. compared to 3.



**Funambulus palmarum robertsoni** Wroughton

*Funambulus palmarum robertsoni* Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 647.

*Type*.—BM No. 12.11.29.92, adult male from Pachmarhi, Hoshangabad, India, collected March 20, 1912, by C. A. Crump.

*Material examined*.—Pachmarhi, 3300 feet, Hoshangbad (CNHM), two; Asirgarh, 1500 feet, Nimar (BM), one; Kol Kaz, 1600 feet, Berar (BM), one; Rarighat, 2500 feet, Hoshangabad (BM), one; Siwal, 1000 feet, Nimar (BM), one; Pachmarhi, 3300 feet, Hoshangabad (BM), one; "Thain," 2000 feet, *Hoshangabad* (BM), two; "Nawapara," Raipur, Central Provinces (AMNH), one.

*Original description*.—" . . . Sombre coloured . . . markedly smaller than *palmarum* . . . saddle brown, with a slight yellow tinge . . . getting darker at certain seasons. The dorsal stripes buffy white. . . . Below, in most cases, 'vinaceous cinnamon,' in some dull white. . . ."

This subspecies differs from others in having no brown on the head; the gray of the sides and nape continues forward onto the crown and face. The width of the median line is nearly five millimeters.

**Funambulus palmarum bengalensis** Wroughton

*Funambulus palmarum bengalensis* Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 648.

*Type*.—BM No. 15.4.3.77, adult female from Gayhundi, 1000 feet, Hazaribagh, Bihar, India, collected May 10, 1914, by C. A. Crump.

*Material examined*.—"Jagodih," 600 feet, *Hazaribagh*, Bihar and Orissa (BM), one; Muhammedganj, Behar (AMNH), one.

*Original description*.—" . . . resembling *robertsoni* in its small size, but distinguishable by its much larger teeth and . . . an ochraceous tinge on flank. Below invariably dull white."

The width of the median line is about three millimeters.

The pelage of the example from Muhammedganj differs from our description of the typical race: in having a Blackish Brown (2) dorsal area; in having the stripes extend, albeit faintly, upon the shoulders to the nape; in having the mid-stripe but half the width of the laterals; in having the Cinnamon-Rufous of the anal area extend out the ventral pelage of the tail about 20 mm. before paling to Light Ochraceous Buff, then Light Buff; and in having a fuller tail (30 mm. wide with hairs to 25 mm. long).

*Habits*.—A field observer collecting this form makes the following remarks: "Blanford states this squirrel is not found in forests, but in my experience though partial to the neighbourhood of cultivation, it may like *pennanti* be found far into the forests." (C. A. Crump in Wroughton, 1915c, p. 108.)

***Funambulus palmarum favonicus* Thomas and Wroughton**

*Funambulus palmarum favonicus* Thomas and Wroughton, 1915, Jour. Bombay Nat. Hist. Soc., 24, p. 39.

*Funambulus palmarum matugamensis* Lindsay, 1926, Jour. Bombay Nat. Hist. Soc., 31, p. 239.

*Types*.—*Funambulus p. favonicus*, BM No. 15.7.1.2, young (original description says "adult") female from Udugama, Southern Province, Ceylon, collected April 23, 1913, by E. W. Mayor; *F. p. matugamensis*, BM No. 27.11.17.1, adult female from Anisigalla, Matugama, 30 miles southeast of Columbo, Ceylon.

*Material examined*.—"Anesagalla" [Anisigalla] 100 feet, *Matugama*, Kalutara, Western Province (BM), 18; "St. George," 300 feet, Matugama, Western Province (BM), one; Kottawa, Southern Province (BM), two; Ranna, Southern Province (BM), one; Udu-gama, Southern Province (BM), six (topotypes).

*Original description*.—" . . . darker than true *palmarum*, owing to the greater amount of black grizzling. The saddle much darker. . . . The central dorsal stripe white, the lateral ones ochraceous buff. Below white. Tail below 'cinnamon rufous' . . . i.e. red rather than yellow. Feet a fine grizzle of black and buff. . . . When these [18] specimens were laid out in a row their warmer colouring, strong colour contrasts, and grizzled feet differentiate them from the sober, dull-coloured *palmarum palmarum*."

The top of the face and rostrum of the type is a rather bright reddish brown. The under parts are dull whitish with gray hair bases. The under side of the tail is yellowish-brown.

*Dimensions*.—Phillips (1935, p. 231) provides averages of measurements in millimeters for 30 males and 30 females of *favonicus*. These are respectively: length of head and body, 144.7 and 142; length of tail, 124.4 and 137; length of hind foot, 34.5 and 34.5; length of ear, 15.2 and 16. He comments that many had the ends of their tails "damaged," especially the males. We take this to mean that the tails of many were short because the end was missing. He also gives maxima for these measurements. These are, for males and females respectively: 180 and 150, 157 and 169, 37 and 37, 17 and 17.

**Funambulus palmarum kelaarti** (Blyth)

*Sciurus kelaarti* Blyth, 1851, Jour. Asiatic Soc. Bengal, **20**, p. 166.

*Type*.—IM 9479, a parous female from Hambantotte, Ceylon, collected in 1845 by E. L. Layard.

*Material examined*, all from Ceylon.—Aripo [Arippu], northwest Ceylon<sup>1</sup> (BM), two; A'pura [Anuradhapura], North Central Province (BM), one; Kala-oya [a river], North Western Province (BM), nine; Putlam [Puttalam], North Western Province (BM), one; Man-keni, Eastern Province (BM), two; Inganiyagala, 100 feet, near Kal-munai, Eastern Province (BM), five; Hambanpota [Hambantota], Southern Province (BM), 11; Wellawaya, 608 feet, Uva Province (BM), two; "Micouralia" (BM), one.

*Original description*.—" . . . *kelaarti* entirely replaces all the other small Sciuri from Tangalle and Hambantotte, and I fancy extends round to Trincomali. . . . It [is] . . . like . . . *palmarum* of India, but the head is much redder, the halves of the back and belly are more blended, and the animal is altogether smaller. . . ."

Previously, Blyth (1849, p. 602) had written substantially the above in a footnote, without, however, giving the squirrel in question a name.

*Dimensions*.—Phillips (1935, p. 229) presents averages of measurements in millimeters taken on eight males and six females of *kelaarti*. These are respectively: length of head and body, 143 and 139.6; length of tail, 136.7 and 106; length of hind foot, 34.5 and 35.5; length of ear, 18 and 17.5. (Note that Phillips' average measurements of the tails of *favonicus* evidently included ones with part of their natural length missing.) He also gave maxima for these dimensions, and these are respectively: 149 and 151, 151 and 160, 37 and 37, 20 and 19.

*Type description*.—Color characteristics of the type of *kelaarti*, examined in 1960: The pelage of the crown is Russet (XV) and ends abruptly along a line between the ears. The agouti pelage of the nape and shoulders is close to Dresden Brown, or, if one ignore the yellowing effect of the light bands, Saccardo's Umber (XXIV). The postauricular patch is Pinkish Buff. The eye ring and sides of face below and in front of the eye are Light Ochraceous Buff (XV). The pelage color approaches Ochraceous Tawny between the eye and ear.

<sup>1</sup> There is another Arippe in Eastern Province (latitude 08° 19' N., longitude 81° 20' E.) which may better be the source of this material. So treated on distribution map.

Dark pelage on the back between the lines is Mummy Brown at its greatest intensity at the middle of its length, gradually grading into the shoulder color anteriorly, but going through the redder Prouts Brown and then Mars Brown before grading into the Dresden Brown of the rump and thighs. The dark saddle area outside of the light lines borders abruptly on the sides without diminution of intensity. The sides are about Isabella Color (XXX). The dorsal pelage on the limbs is like that of the shoulders but paler. The three light lines on the back are Light Ochraceous Buff, the lateral ones reach five millimeters wide, the middle one only two. The light lines disappear in the shoulder and rump areas but are intense for 70 or 80 millimeters. The ventral pelage is Naples Yellow (XVI) and borders on the color of the sides rather abruptly. The midvane of the under side of the tail is Tawny (XV). The tail hairs have three blackish bands, the proximal two each about 2 mm. long, the distal one about 4 mm. The tail pelage is worn and a little faded but a black pencil is evident at the tip, and the hairs are about 30 mm. long.

### ***Funambulus palmarum brodiei* (Blyth)**

*Sciurus brodiei* Blyth, 1849, Jour. Asiatic Soc. Bengal, 18, p. 602.

*Funambulus palmarum brodiei*, Thomas and Wroughton, 1915, Jour. Bombay Nat. Hist. Soc., 24, p. 40.

*Type*.—IM No. 9840, collected by E. L. Layard in Ceylon.

*Material examined*.—Cheddikakulam [Cheddikulam], Northern Province, Ceylon (BM), nine, (CNHM), two.

*Original description*.—"Very similar to [*tristriatus*] but distinguished by its considerably paler colour, and especially by having a very long pencil tuft ( $3\frac{1}{2}$  in.) at the extremity of tail, quite different from what is ever seen in *tristriatus* . . . 'confined to Palmyra-tree district from Puttulam to Jaffna. How much further round the coast I do not know."

*Type description*.—The type of *Funambulus brodiei* has the general appearance of *palmarum*. The three dorsal stripes, however, pass through a dark saddle-like area on the back, about 60 mm. long and 40 mm. in overall width. The width of the dark pelage between median and lateral pale lines is 9 mm., its width beyond the lateral lines about 6 mm. The pale median stripe is 4 mm. wide, the lateral ones 6 mm. The dorsal color becomes russet on the head and rostrum. The tail is a grizzle of black and buff. The hands and feet are light grayish buff. The under parts to the chin, and up the sides



of the head to the bases of the ears, also the insides of the limbs, are dull buffy yellow. The skull of the type is very badly broken and the nasals missing. The teeth show a moderate degree of wear, but the almost unworn condition of the fourth premolar and first molar suggests that the animal is a young adult. The maxilla spreads over a considerable area on the dorsal surface of the skull.

*Dimensions*.—Phillips (1935, p. 227) records averages of measurements made in millimeters on but four males and three females of *brodiei*, and these are respectively: length of head and body, 150 and 148.7; length of tail, 148 and 139; length of hind foot, 35 and 34; and length of ear, 17 and 14.3. The maxima that he provides with the above dimensions are respectively: 162 and 153, 148 and 146, 37 and 34, 17 and 15.

### ***Funambulus palmarum olympius* Thomas and Wroughton**

*Funambulus palmarum olympius* Thomas and Wroughton, 1915, Jour. Bombay Nat. Hist. Soc., 24, p. 41.

*Type*.—BM No. 15.7.1.3, adult female from Urugalla, 1600 feet central highlands, Ceylon, collected February 25, 1914, by E. W. Mayor.

*Material examined*.—Kandy (BM), one; "Lindoehn," 4200 feet (BM), one; Peradeniya [Peradeniya], 1600 feet (BM), 11; "Urugala," 1600 feet, Central Province (BM), nine (topotypes), (CNHM), two.

*Original description*.—"A dark highland form. Resembling *brodiei* but much darker. The saddle is commonly almost black and the central dorsal stripe paler than the lateral ones, often white. Lower side of the midrib of tail is much darker chestnut than in *brodiei*. Feet are darker even than in *favonicus*. Below dull white."

This is quite the darkest of the races of *palmarum*; the general dorsal color is blackish gray. The face is brownish-gray—about like the sides of the body. The under parts are dull whitish with gray hair bases. The under side of the tail is yellow-brown.

*Dimensions*.—Phillips (1935, p. 234) provides averages and maxima of measurements taken in millimeters on 13 males and 11 females, and the averages are respectively: length of head and body, 157.5 and 156.5; length of tail, 150.5 and 135.5; length of hind foot, 38.5 and 37.9; length of ear, 17.5 and 17.5. The maxima are: 166 and 164, length of head and body, 168 and 167, length of tail, 40 and 40, length of hind foot, and 20 and 20 length of ear.



**Funambulus tristriatus** (Waterhouse)

*Definition*.—This species is constituted by those large, dark, three-striped forms inhabiting the evergreen rainforest of the Western Ghats of peninsular India as shown in our map Figure 9.

*Diagnosis*.—(1) *Funambulus tristriatus* has three light longitudinal lines in the dorsal pelage. (2) The occipitonasal length of skull in adults with toothwear exceeds 40 mm.

The above characters distinguish species *tristriatus* from the congeneric species as follows: *pennanti* by 1; *palmarum* by 2; *layardi* by 2; and *sublineatus* by 2.

*Systematic history*.—The distinctness of *Funambulus tristriatus* from *palmarum* was recognized first by Waterhouse, and subsequently by Wroughton (1905, p. 410), as "the forest form of *palmarum*." Later Wroughton (1916d) distinguished the two species by the larger skulls of *tristriatus*, and in the same article described several new races. Later Wroughton and Davidson (1919) proposed two additional forms, one of which extended the range of the species northward along the west coast to Bombay. Pocock (1923) then (in error as shown above) distinguished this *tristriatus* group generically as *Tamiodes*.

*Relationships to other species*.—*Funambulus tristriatus* is considerably larger than either *palmarum* or *pennanti* (see Table 3) and is much darker, except for the dark race of *palmarum* on Ceylon. The tail is much fuller—its width across the pelage about 25 mm. The longitudinal pale lines are only three. The median line is weak, dull yellow and 3 mm. wide; the two lateral lines are dull white, and about 4 mm. wide. The under parts are dull buffy white, with distinctly gray bases to the hairs. The scrotal area and under side of tail (bases of tail hairs) are russet.

This purely tropical species occurs in the forests of the mountains along the western coast of the Indian peninsula from about latitude 19° N., or the city of Bombay, southward well into Travancore. Study to define further the distribution of subspecies *tristriatus* and *wroughtoni* in relation to each other and to species *palmarum* in Coorg, Mysore, Malabar, and the Nilgiris would be rewarding.

**Funambulus tristriatus tristriatus** (Waterhouse)

*Sciurus tristriatus* Waterhouse, 1837, Mag. Nat. Hist., (new ser.), 1, p. 499.

*Sciurus dussumieri* Milne-Edwards, 1867, Rev. Mag. Zool., 19, p. 226.

*Funambulus tristriatus annandalei* Robinson, 1917, Rec. Indian Mus., 13, p. 41.

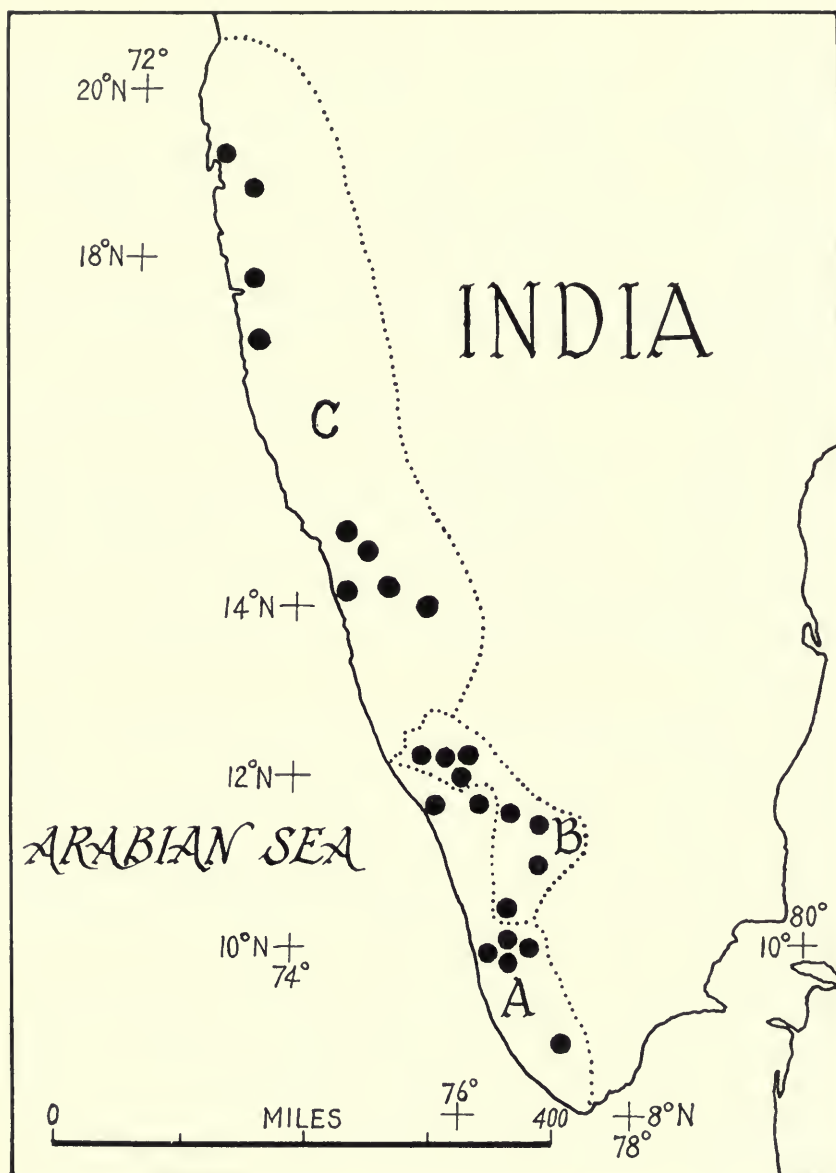


FIG. 9. Ranges of the geographic races of the Western Ghats squirrel, *Funambulus tristriatus*, as shown by material examined. Subspecies: A, *tristriatus*; B, *wroughtoni*; C, *numaris*.

*Types*.—*Sciurus tristriatus*, BM No. 55.12.24.112, adult male from "India," here restricted to the Western Ghats south of 12° N. latitude; *Sciurus dussumieri*, MNHN No. 1838 (292), adult from Malabar; *Funambulus t. annandalei* (not seen), IM No. 8498, adult female, from Sasthancotta, west side of Western Ghats, Travancore, collected November 8, 1908, by N. Annandale.

*Material examined*.—"Paumpa," North Travancore (BM), three; "Merchiston," Travancore (BM), two; "Paibuna," North Travancore (BM), one; "Poothota," Vycoona District, North Travancore (BM), three; "Travancore," 4000 feet (BM), six; "Tyebautuchary," North Travancore (BM), two; "Bonaccord," Glen Brith Estate (BM), one; "India" (MCZ), one; "Kellengode," South India (AMNH), two; Kuttyani [Kuttyadi, Malabar], 250 feet (BM), one; "Mellacotta," Wynaad (BM), one; "Madras" (BM), five; "Poumodi" [Ponmudi, Travancore], 2000 feet (BM), two.

Width of the lateral line is 4 mm., of the median line 2 mm. in the type specimen. The type of *dussumieri* has the median pale line 45 mm. in length, and the lateral lines 70 mm. The widths are: median line, 2 mm.; laterals, between 3 and 4 mm. The under side of the tail is rather bright rufescent from the vent almost to the tip.

*Discussion*.—Miss Ryley (1913, p. 437) remarked that the type of *tristriatus* ". . . very probably . . . came from Travancore as it agrees best with a small series from that district." Nevertheless, when Robinson (1917, p. 41) described *annandalei* from Travancore, citing this paper of Miss Ryley, he ignored the above-quoted observation of hers and commented, "In default of authenticated skins from Madras I have taken modern skins from Kanara as typical of *F. . . tristriatus*, Waterh., though it is by no means impossible that these will prove to represent yet another form." The Kanara series had in fact already been identified as belonging to a new subspecies of *tristriatus* described by Wroughton (1916, p. 646), who tersely restricted the type locality of *tristriatus* to Travancore. Wroughton and Davidson (1919, p. 728) then reported, "The British Museum has a series, sent by Capt. H. Ferguson, from Trevandrum [in Travancore], which are undoubted *tristriatus*, with the type of which they agree in all essential particulars." Zahn (1942, p. 68) records the type locality of *tristriatus* as Travancore. Ellerman (1940, p. 379) and Ellerman and Morrison-Scott (1951, p. 495) employ "Madras, India (by designation)." The use of "Madras" is unfortunate, for although the state of Madras formerly included what was still earlier Travancore, it does not now, and in any case Madras includes a

much broader area than that in which anyone presumes subspecies *tristriatus* to occur. The correct political designation at the time of our writing is southern Kerala, but Western Ghats south of 12° north latitude is a better description, and in using this we are honoring and slightly refining Wroughton's (1916, p. 645) restriction of the type locality to Travancore.

### ***Funambulus tristriatus wroughtoni* Riley**

*Funambulus wroughtoni* Riley, 1913, Jour. Bombay Nat. Hist. Soc., 22, p. 437.

*Types*.—*F. wroughtoni*, BM No. 13.8.22.48, old female from Sri-mangala, 2782 feet, South Coorg, peninsular India, collected February 6, 1913, by G. C. Shortridge.

*Material examined*.—"Cotengody Estate," 3500 feet [*Nelliampathi Hills*], Cochin (BM), four; "Shernelly," 1500 feet, Cochin (BM), four; Mudumalai, 3285 feet, Nilgiri Hills (AMNH), one; "Dirajpet," 3000 feet, *South Coorg* (BM), three; "Makut," 250 feet, *South Coorg* (BM), two; "Srimangala," 2782 feet, *South Coorg* (BM), one; "Wotekotti," 2000 feet, *South Coorg* (BM), one, (CNHM), two; "Benhope," 3000–4000 feet, Nilgiri Hills (CNHM), two.

*Original description*.—" . . . clearly an ally of [*tristriatus*] . . . general colour greyish brown . . . three pale yellow longitudinal stripes . . . the middle one being much shorter and narrower than the lateral ones. . . . Saddle rich chestnut, this being one of the most striking characteristics . . . distinguished by its large size, the conspicuous chestnut color of the dorsal fur, and the black and white appearance of its tail.

"Examples from N. Kanara and Dharwar decidedly smaller, and have a different general colour and are nearer to the type of *F. tristriatus*.

"The series of 35 . . . from Coorg is very constant in colouring, only three . . . having any black on the back, whereas the type, four of the five from Travancore, and about half of the specimens from N. Kanara have the saddle black . . ."

The pale stripes extend from shoulders to rump; the median stripe is 2 mm. wide; lateral ones are 3 to 4 mm. wide. The one example in the collections of the American Museum of Natural History has three bands of black on the tail hairs.

**Funambulus tristriatus numarius** Wroughton

*Funambulus tristriatus numarius* Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 646.

*Funambulus thomasi* Wroughton and Davidson, 1919, Jour. Bombay Nat. Hist. Soc., 26, p. 729.

*Types*.—*Funambulus t. numarius*, BM No. 15.7.3.26, adult male from Helwak, Western Ghats, Satara District, Bombay, India, taken December 7, 1914, by S. H. Prater; *thomasi*, BM No. 19.6.3.50, Khandala, 2000 feet, Western Ghats, Bombay, India, an adult female taken April 11, 1918, by Philip Gosse.

*Material examined*.—"Potoli," 1800 feet, North Kanara (BM), four; Gersappa [Gersoppa], sea level, Kanara (BM), two; Helwak, Satara District (BM), eight, (CNHM), two (topotypes); "Hulekal," 1500 feet, near Sirsi, Kanara (BM), one; Khandala, 1800 feet (BM), two (topotypes); Khed, Ratnagiri District (BM), two; Sirsi, 1500 feet, Kanara (BM), one; Thana (BM), two; "Kardibetta Forest," 2500 feet, Shimoga District (BM), one; Sagar, 2500 feet, Shimoga District (BM), one; "Devikop," 2000 feet, South Mahratta (BM), one.

*Original description*.—"A local race of *tristriatus*, slightly smaller. . . . General colour above a grizzle of black, and buff giving a general effect of yellowish 'drab' approaching 'isabella colour,' the saddle . . . darker . . . with three longitudinal pale buff lines, broader and better marked than in true *tristriatus*. Face coloured like the back with a yellow suffusion, cheeks buff. In the summer coat the . . . saddle becomes jet black, and the dorsal stripes tend to become white, while the . . . face becomes tawny and the cheeks more ochraceous. Below dull white except the anal region, which like the under side of the tail, is a bright 'cinnamon rufous'; above the tail hairs are black with white tips, arranged . . . to indicate . . . a barring . . .

"Shortridge obtained 35 specimens in Dharwar and Kanara which are clearly intermediates between [*numarius*] and *tristriatus*. . . ."

**Funambulus layardi** (Blyth)

*Definition*.—This species is constituted by the largest and most colorful squirrels of the genus *Funambulus* on Ceylon, subspecies *layardi* and *signatus*, and in the jungles of Travancore by the subspecies *dravidianus*. See the species distribution in Figure 10.

*Diagnosis*.—The ventral pelage is entirely orange chestnut to cinnamon or may have the thoracic part yellowish orange.



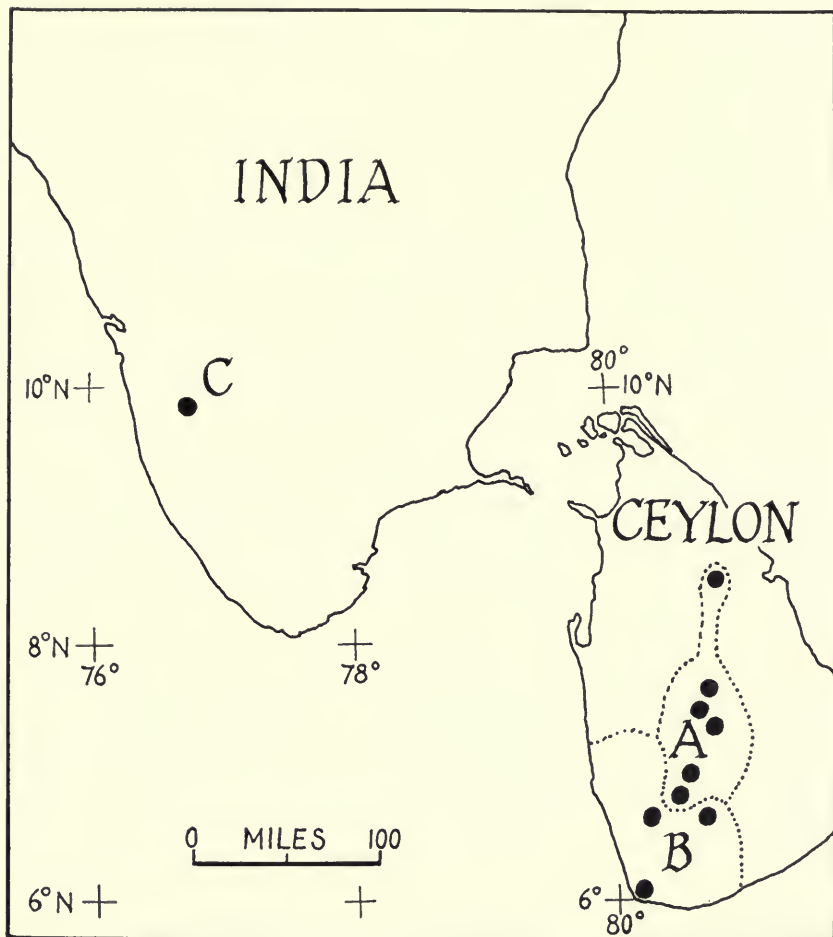


FIG. 10. Distribution of the Sinhalese jungle squirrel, *Funambulus layardi*, plotted from Ceylon localities recorded by Phillips (1935). Subspecies: A, *layardi*; B, *signatus*; C, *dravidianus*.

*Relationships to other species.*—The species *layardi* seems to be the ecological equivalent on Ceylon of *tristriatus* in the Western Ghats. This is to say that species *layardi* is larger than forms of the species *palmarum* and *sublineatus* on Ceylon (see measurements given in pertinent subspecies accounts and in Table 3) and occupies principally the old evergreen rainforest. The fact that *layardi* seems also to occur in the southern Western Ghats, invites a comparative investigation of the ecology and distribution of these two species on

the mainland. Hutton (1949, p. 692) reports the species *layardi* very common in the High Wavy Mountains of the southwest corner of Madura District, Madras, on the Travancore border, and *tristriatus* seems to be absent from this locality.

### ***Funambulus layardi layardi* (Blyth)**

*Sciurus layardi* Blyth, 1849, Jour. Asiatic Soc., Bengal, 18, p. 602.

*Type*.—IM No. 9481 (ASB 341A), skin only, sex unknown, taken in the "uplands" of Ceylon in 1843 by E. L. Layard.

*Material examined*.—"Mousa Kaida" [Mousakande, *Gammaduwa*, Ceylon], 3000 feet (BM), one, (NMC), one; "Thimbulketiya," Ceylon (NMC), one.

*Type description*.—The dorsal color of the type is now (1951) grizzled dark grayish brown. Of the three pale dorsal lines the median one is bright orange-yellow and 2-3 mm. wide; the lateral lines are only slightly paler than the body color and 3 mm. wide. The areas between the median and lateral lines are blackish brown. A faint dark line appears outside each lateral line. The median line extends from nape to rump and is 110 mm. long, the laterals from shoulder to rump, 85 mm. long. The head is colored like the back. The tail is grizzled like the body, its hairs with yellow-buff bases, long black subterminal rings, each 11 mm. in length, and buffy white tips. The end of the tail is black. The under parts are russet, the hairs with gray bases.

*Dimensions*.—Phillips (1935, p. 237) offers averages and maxima of measurements taken in millimeters on three males and six females of *F. l. layardi*. The averages are respectively: length of head and body, 165 and 155.5; length of tail, 144 and 142; length of hind foot, 37.5 and 37.5; length of ear, 16 and 15.5. The maxima are respectively: 168 and 160, 145 and 149, 39 and 39, and 16 and 16.

Thomas (1924, p. 241) comments, ". . . the type of *layardi* came from the Ambigamoa Hills which are in the highlands of the Central Province (7°N., 80° 30' E.) . . ."

### ***Funambulus layardi signatus* Thomas**

*Funambulus layardi signatus* Thomas, 1924, Ann. Mag. Nat. Hist., (ser. 9), 13, p. 241.

*Type*.—BM No. 15.3.1.73, young male from Rakwana, Ratnapura District, 115 feet, Ceylon, collected February 17, 1914, by E. W. Mayor.

*Material examined*.—Southeast of Ratnapura, Ceylon (BM), one.

*Original description*.—"Similar in all respects to true *layardi*, but the light median dorsal line, instead of being narrow (about 3 mm.) and pale buffy, is broader (nearly 5 mm.) and of a rich ochraceous or flame-colour."

*Dimensions*.—In Phillips (1935, p. 239) one finds averages of measurements taken in millimeters on eight males: length of head and body, 153.7; length of tail, 140.8; length of hind foot, 35.2; length of ear, 17. The maxima for the same series are respectively: 160, 153, 38, and 19.

### ***Funambulus layardi dravidianus* Robinson**

*Funambulus layardi dravidianus* Robinson, 1917, Rec. Indian Mus., 13, p. 42.

*Type*.—IM No. 10143 (=9773), young individual from western side of the Western Ghats, Travancore, India, taken by Nelson Annandale. The reported presence of deciduous premolars in this type is the basis, acceptable to us, for regarding it as immature (e.g., Moore, 1956, pp. 46, 47).

*Material examined*.—"India" (MNHN), one.

*Original description*.—"Differs from [*layardi*] in having the top of the head and cheeks rich rufous orange, and under surface yellowish orange instead of dull chestnut. Area between light lines on back, deep lustrous black."

*Type description*.—The general color of the upper parts are as in *F. l. layardi* of Ceylon, but the head is much more reddish and grizzled with black. The dorsal area between and outside the three light lines is much blacker. The three lines are colored alike, light orange-buff. The width of the median line is 2 mm., of the lateral lines, 3 mm. The hands, feet, and tail are as in *layardi*. The under parts differ sharply from the typical subspecies. The red of the crown becomes almost clear chestnut on sides of the head and on either side of the throat. The throat and neck beneath are cinnamon, changing to yellow hairs (with gray bases) on the thorax. Behind this the pelage becomes dull brownish cinnamon (hairs with gray bases). The insides of the fore limbs are yellow-buff, of the hind limbs, brownish cinnamon. The under side of the base of the tail is brighter reddish cinnamon.

Although we have been able to examine but two specimens of this form, Hutton (1949, p. 692) in reporting on it from the southwest corner of Madura District, Madras, on the Travancore border, re-

garded it, "A very common little animal found throughout the hills above 3,000 feet." Among other comments he adds, "They often forage on the ground for insects." This was apparently in continuous evergreen jungle.

### ***Funambulus sublineatus* (Waterhouse)**

*Definition.*—This species is constituted by the most diminutive forms of the genus *Funambulus*, and these are all endemic to the southern tip of peninsular India and to Ceylon as shown in Figure 11.

*Diagnosis.*—(1) The fur is long and soft, tending to obscure the three rather faint light stripes. (2) The baculum is bifurcated and the tips end in rather spherical nobs. (3) The supra-orbital notches are obsolescent or absent.

*Relationships to other species.*—On Ceylon Phillips (1935, p. 240) states clearly that *sublineatus* ". . . is confined to the jungles of the hill and wet zones and is not found at all in the dry zone." And (p. 241) he says, "Its favorite haunt is a dense bamboo brake or patch of . . . *Strobilanthes* sp. and undergrowth in the jungle. . . . It spends almost as much time upon the ground as in the undergrowth, and though it [is observed] to examine the rough bark of large trees, it is but rarely seen in their upper branches."

The larger species, *layardi*, occurs in these same wet jungles of the same central hill zone and southwestern zone of Ceylon as *sublineatus*, according to Phillips (1935, pp. 237–239), in ". . . damp, heavy forests of a medium altitude, from about 1,000 ft. to 4,000 ft.; it is found only in the tallest trees . . . it seems to spend much of the day among the foliage of the tops of the tallest trees. . . . It is, however, in no way averse to descending to the ground and may frequently be seen examining the boles of the forest giants or making its way through the undergrowth." For other differences between these two species in Ceylon, and comment on it, see "Intrageneric Relationships" in the above account of the genus *Funambulus*.

### ***Funambulus sublineatus sublineatus* (Waterhouse)**

*Sciurus sublineatus* Waterhouse, 1838, Proc. Zool. Soc. London, 1838, p. 19.

*Sciurus delesserti* Gervais, 1841, L'Institut, p. 171.

*Sciurus trilineatus* Blyth, 1849, Jour. Asiatic Soc. Bengal, 18, p. 602.

*Types.*—*Sciurus sublineatus*, BM No. 55.12.24.321, young male from the Nilgiri Hills, Madras, India; *delesserti*, BM No. 217a, adult male from Nilgiri Hills, India; *trilineatus*, not found.

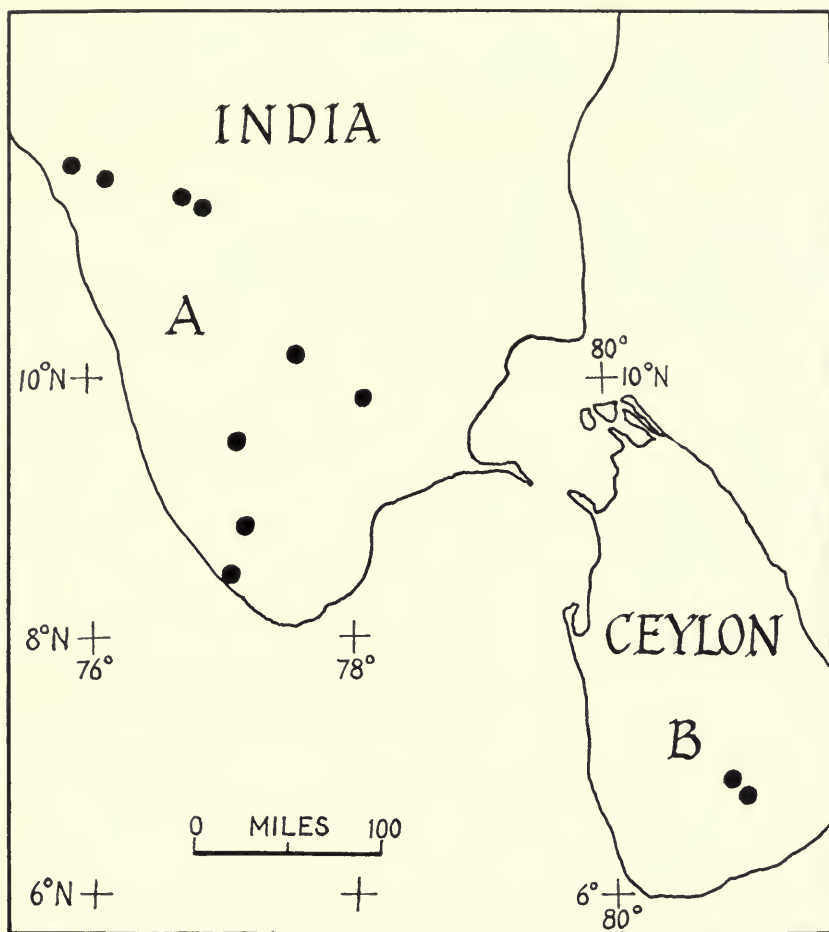


FIG. 11. Geographic distribution of the dusky Indian jungle squirrel, *Funambulus sublineatus*, as indicated from material examined. Subspecies: A, *sublineatus*; B, *obscurus*.

*Material examined*.—"Benhope," 3000–4000 feet, Nilgiri Hills (BM), one; "Bombay Shola," 7000 feet, Kodai Kanal [Kodaikanal], Palni Hills (BM), three; Coonoor, Nilgiri Hills (BM), two; "High Range," Trevandrum, Travancore (BM), one; "Madras" (BM), one; Manantoddy, Wynaad (BM), one; "Rookery Kil (Estate)," 3800 feet Kotagiri, Nilgiri Hills (BM), one; "Travancore," 4500–5000 feet (BM), two; "Huvinakadw Estate," 2843 feet, Kirtta, S. Coorg (BM), one; Kuttyani [Kuttyadi], 250 feet (BM), four; Ponmudi, 2000 feet



(BM), two; "Shernelly," 1500 feet, Cochin, S. India (BM), one; "Tiger Shola," 5500 feet (BM), one; "Cumbum," 5000 feet, High Wavy Mts., Madura (CNHM), two; Ootacamund, Nilgiri Hills (UMMZ), one.

*Original description* (translation from the Latin).—"Above fusco-olivaceous, washed with yellowish; four black dorsal lines, three whitish, running from shoulders to rump; under parts yellowish; tail ringed black and yellow.

"... four dark and three pale lines on the back: these lines . . . are very narrow . . . are not continued onto the shoulders, [nor] over the haunches. The general colour olive-brown . . . throat, chest and rump are whitish, . . . belly is yellow . . ."

*Pelage color*.—The CNHM study skins are an agouti of about Dresden Brown and are uniformly so from snout to ankles excepting for the three light stripes which are only somewhat paler. The four dark lines embrace the light ones and are slightly wider. The tails seem not at all distichous and taper to a point.

*Habits*.—Hutton (1949, p. 692) reporting on this form in the southwest corner of Madura District, Madras, on the Travancore border, remarks, "It does not like thick forests and so is not often seen in our jungles [on a plateau above 4000 feet]. It is quite common in the Varushnaad [Valley], and in light evergreen forest. It prefers country that has a light rainfall and [is] fairly sheltered. In the forests at the south of the Varushnaad [Valley], however, it is quite common up to 5,000 ft."

### ***Funambulus sublineatus obscurus* (Pelzeln and Kohl)**

*Sciurus palmarum* var. *obscura* Pelzeln and Kohl, 1886, Verhandl. Zool. Bot. Gesell. Wien, 35, p. 525.

*Funambulus kathleenae* Thomas and Wroughton, 1915, Jour. Bombay Nat. Hist. Soc., 24, p. 38.

*Types*.—*Sciurus p. obscura*, not seen, from the "Mountains of Ceylon, 1000 meters"; *kathleenae*, BM No. 15.7.1.1, young male from Kottawa, Southern Province, Ceylon, collected April 11, 1913, by E. W. Mayor.

*Material examined*, all from Ceylon.—Pattipola, 6210 feet, Central Province (BM), two; West Kaputale [Haputale], 6000 feet, Ohiya (NMC), one, (BM), three; Gammaduwa, 3400 feet, Mousakande (MCZ), one, (NMC), one.

*Original descriptions*.—*Sciurus p. obscurus*, "From the mountains (1,000 meters elev.); the ones from the lowlands are of lighter color.

The example under consideration is distinguished from the normal by the much darker coloring. The upper side is brown-gray; each hair shows a reddish yellow ring before its dark tip. The back with four dark chestnut-brown longitudinal stripes which are separated from one another by three much narrower pale yellow longitudinal stripes. The under side is lighter than the upper and shows more reddish-yellow."

*Funambulus kathleenae*, "The readiest means of distinguishing *kathleenae* from *sublineatus* is the much greater width of the dark dorsal stripes, which are 7-8 mm. in breadth, as contrasted with 4-5."

*Habits*.—This form is confined to Ceylon. According to Phillips (1935, p. 240), ". . . this little squirrel [occurs in] the jungles of the hills, from the highest peaks down to about 2,000 or 1,500 ft.; but . . . in the southwest generally, it descends to the lower foothills . . . through the damp, hilly jungle of the low-country . . . to near the sea coast in [the Southern Province]. It is confined to the jungles of the hill and wet-zones and is not found at all in the dry-zone."

*Dimensions*.—For dimensions of this form Phillips (1935, p. 240) presents averages and maxima of measurements taken in millimeters on eight males and eight females. The averages are respectively: length of head and body, 118 and 112.8; length of tail, 109.5 and 103.5; length of hind foot, 28 and 30.3; length of ear, 14.4 and 14.5. The respective maxima are: 126 and 124, 117 and 113, 32 and 32, and 16 and 18. Maximum weight of either sex is  $2\frac{1}{4}$  ounces.

## COMMON TREE SQUIRRELS

### Genus CALLOSCIURUS Gray, 1867

*Callosciurus* Gray, 1867, Ann. Mag. Nat. Hist., (ser. 3), **20**, p. 277.

*Baginia* Gray, 1867, Ann. Mag. Nat. Hist., (ser. 3), **20**, p. 279.

*Erythrosciurus* Gray, 1867, Ann. Mag. Nat. Hist., (ser. 3), **20**, p. 285.

*Heterosciurus* Trouessart, Le Naturaliste, **1**, p. 292.

*Tomeutes* Thomas, 1915, Ann. Mag. Nat. Hist., (ser. 8), **15**, p. 385.

*Type species*.—*Callosciurus*, *Sciurus rafflesi* Vogors and Horsfield, the Sumatran form of *C. prevosti* Demarest from Malacca; *Baginia*, *Sciurus notatus* Boddaert from Java; *Erythrosciurus*, *Sciurus ferrugineus* Cuvier from Burma; *Heterosciurus*, *Sciurus erythraeus* Pallas from Assam, India; *Tomeutes*, *Sciurus lokroides* Hodgson from Nepal a subspecies of *C. pygerythrus* Geoffroy from Burma.

*Definition*.—*Callosciurus* is a genus of tree squirrels endemic to the Malaysian and Indochinese subregions, and is composed of the species *erythraeus*, *ferrugineus*, *flavimanus*, *finlaysoni*, *caniceps*, *phayrei*, *inornatus*, and *pygerythrus* of the Indochinese Subregion (see their ranges in Figures 13–16) and extraterritorial species *prevosti*, *notatus*, *nigrovittatus*, *albescens*, and *melanogaster* of the Malaysian Subregion.

*Diagnosis*.—*Callosciurus* possesses the following characteristics: (1) The least interorbital breadth exceeds the greatest length of nasal. (2) There are no pronounced longitudinal stripes on the back (although there may be on the sides and venter). (3) There is a single, unforked, bony septum across the chamber of the auditory bulla. (4) The third upper premolar is present. (5) The coronoid process of the mandible is high and falcate. (6) The upper edge of the infra-orbital foramen is well separated from the maxillo-premaxillary suture. (7) The baculum consists of two separate parts, a shaft and a blade. (8) Orbit length exceeds 13 mm. (9) The supra-orbital notches are obsolescent.

*Callosciurus* is distinguished from the other genera of the Indian and Indochinese subregions by the above characters as follows: from *Ratufa* by 3, 4, 6, and 7; *Funambulus* by 2, 5, and 7; *Tamiops* by

2 and 8; *Dremomys* 1; *Menetes* by 1 and 2; and *Sciurotamias* by 1, 3, and 9.

*Intrageneric relationships.*—Species of the genus *Callosciurus* are the common tree squirrels of the Indochinese and Malaysian subregions. No members of this genus cross the Garo-Rajmahal Gap into the Indian Subregion. Throughout a great deal of the Indochinese Subregion there are two species of *Callosciurus* present in any one area. We recognize eight species of *Callosciurus* in the Indochinese Subregion, and we consider them more closely related to each other than to any of the other species of *Callosciurus*, which occur only south of the Isthmus of Kra. The evidence so far advanced (Moore, 1961a, p. 14) on which this monophyletally of the eight mainland species is inferred, is that the number of pairs of functional mammae is consistently only two; whereas the characteristic number of pairs in the several Malaysian species is three. This may be too weak a distinction to be regarded as subgeneric, but it does seem to distinguish what is a phylogenetic group higher than an artenkreis and composed of two artenkreis. In further study this arrangement will probably be found to be supported in certain general characteristics of the pelage. For convenience until further study is accomplished, one of these two natural units may be called the mainland unit and the other the Sundaland unit of genus *Callosciurus*. There is some overlap in the distribution of these two units. The Malay Peninsula south of the Isthmus of Kra is occupied by two species of the mainland unit as well as three species of the Sundaland unit.

The mainland unit, we find, consists of one artenkreis of four allopatric species spread over the whole Indochinese Subregion (*erythraeus*, *ferrugineus*, *flavimanus*, and *finlaysoni*) and a second artenkreis of four allopatric species (*pygerythrus*, *phayrei*, *caniceps*, and *inornatus*) which is not so widespread but is on the whole sympatric with the first artenkreis. Although the species listed here bear names employed by Ellerman and Morrison-Scott (1951) and earlier authors, the composition of our species usually differs markedly from earlier concepts. The reasons for the differences will be found in the following accounts.

*Descriptive skull characters.*—(1) Least interorbital breadth approximates orbitonasal length. (2) The occlusal plane is parallel to a plane connecting the tips of the upper incisors and the ventral extremities of the auditory bullae. (3) There is a subsquamosal foramen without vestige, or incipience, of a postglenoid foramen.



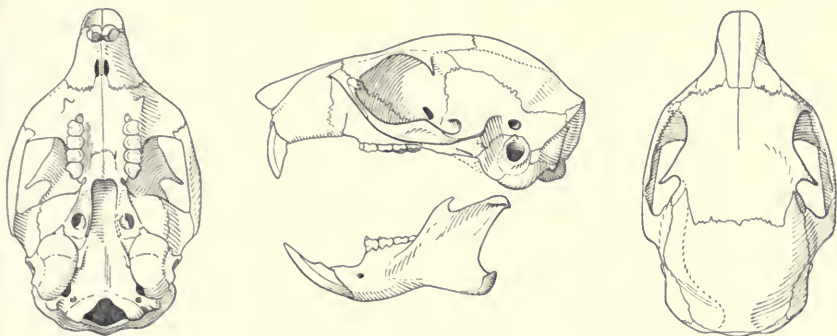


FIG. 12. Skull and left mandible of the Irrawaddy squirrel, *Callosciurus pygerythrus*, AMNH No. 163507,  $\times 1$ . Note the indication of a single septum dividing the auditory bulla.

(4) The frontals are level along the line of least interorbital breadth, but rise to slight inflations where they meet the premaxillaries. (5) The temporal ridges do not form sagittal crests (excepting in a small percent of adult *melanogaster*). (6) The temporal foramen is usually fairly well developed. (7) The jugal is broad with a fairly prominent postorbital process. (8) The lip of the infra-orbital foramen in lateral aspect is ordinarily concave. (9) The upper incisors are proodont.

### *Callosciurus erythraeus* (Pallas)

*Definition.*—*Callosciurus erythraeus* is a species occupying the area of the Indochinese subregion west of the Irrawaddy River and its tributary the Nmai. It consists of the subspecies *erythraeus*, *erythrogaster*, *bhutanensis*, *intermedius*, *sladeni*, *bartoni*, and *haringtoni* and the named forms here included in these subspecies. See the species map in Figure 13.

*Diagnosis.*—In this extraordinarily variable species no pelage (or other) characters are known which distinguish all of its subspecies from all the subspecies of its nearest relatives. See the accounts of the species *flavimanus* and *ferrugineus* for a discussion of the evidence of relationships between *erythraeus* as here recognized and its closest relatives. Table 4 provides some measurements of body and skull for 17 types of named forms of this species.

*Relationships to other species.*—We have been at great pains with *Callosciurus* in the Indochinese Subregion to ascertain where there is evidence of intergradation between forms and where in absence of intergradation there is also positive evidence for recognizing allo-



TABLE 4. Dimensions of Some Type Specimens of the Species *Callosciurus erythraeus*.

	BODY			SKULL						
	Head & Body	Tail	Hind Foot	Total Length	Mas- toid Breadth	Length Nasal	Dia- stema	Palate Length	Bulla Length	Molar Tooth Row
<i>erythrogaster</i>	225±	235±	56	55.7	23.8	17.1	12.8	27.9	11.1	9.8
<i>punctatissimus</i> <sup>1</sup>	240±	190±	56	....	....	16.1	11.5	25.5	....	10.0
<i>nagarum</i>	235±	240±	56	....	24.0	16.7	12.5	26.7	10.0	9.1
<i>kinneari</i>	240	233	60	55.7	24.6	16.9	13.0	27.7	10.2	9.5
<i>crotalius</i>	245	228	54	53.9	23.0	16.6	12.4	26.6	10.7	9.5
<i>bhutanensis</i> <sup>1</sup>	210±	170±	55	....	....	14.5	10.5	24.9	....	9.5
<i>crumpi</i>	205	193	55	52.0	23.1	15.0	12.0	26.1	10.0	10.0
<i>aquilo</i>	230	210	56	55.5	24.1	17.2	12.5	27.1	10.7	10.0
<i>ruber</i>	214	254	57	54.0	22.8	16.7	11.7	26.3	11.7	9.4
<i>midas</i>	248	254	62	57.3	24.5	18.2	12.1	27.5	10.6	9.8
<i>vernayi</i>	240	260	59±	54.8	23.2	17.3	12.2	26.4	11.0	9.7
<i>bartoni</i>	230±	260±	59	57.3	25.1	17.4	12.8	28.3	10.9	9.6
<i>shortridgei</i>	235	262	58	55.7	24.7	15.8	12.2	25.8	10.5	9.1
<i>fryanus</i>	238	273	60	....	25.0	....	12.6	26.7	11.3	9.7
<i>millardi</i>	247	254	58	56.6	24.3	17.3	13.0	27.8	10.7	9.4
<i>careyi</i>	254	284	61	56.7	25.2	17.8	12.9	27.7	11.2	9.8
<i>haringtoni</i> <sup>1</sup>	240±	265±	..	....	....	16.4	11.9	26.5	....	9.6

<sup>1</sup>The types of *punctatissimus*, *bhutanensis* and *haringtoni* are juvenile.

patric species. There is, of course, no question that the "Checklist of Palaearctic and Indian mammals" of Ellerman and Morrison-Scott (1951) is a work of enormous practical value to mammalogists and that it will continue for many years to be as great a help to other as it has been to us in making this revision. But it is only a checklist, and its authors did not, and for such a scope could not, examine evidence in such detail as we have been able to do. Consequently, whereas they surely have made many shrewd taxonomic decisions, discovery that many other decisions are erroneous must be expected when detailed investigation of the available evidence is achieved. Such is the nature of the disagreement found here. The species of *Callosciurus* in the Indochinese Subregion that have been found in the present revision to be evidently good ones have in many instances the names used for species in the Palaearctic and Indian checklist. The subspecies which we find belong in these species, however, differ widely from those which Ellerman and Morrison-Scott (1951) include, and this appears sometimes, as in the case of *flavimanus*, to result from rather basically different concepts.

Species level difference between *erythraeus* and *flavimanus* is based on degree of difference in the areas of most probable contact, or most recent contact, and absence of evidence of intergradation. Distinction at the species level from the other nearest related species, *ferrugineus*, is similarly based on degree of difference and absence of intergrades. Diagnostic difference between the two is that *erythraeus* has mostly agouti dorsal pelage, whereas *ferrugineus* has none and is all red.

Throughout its entire range species *C. erythraeus* is (see Figure 13) sympatric with a smaller species *C. pygerythrus* (compare Figure 16), but Morris (1936, p. 670) noted that there seemed to be some ecological or other factor along the Chindwin River enabling one or the other species to be the more abundant, ". . . from Singkaling Khamti southwards the east bank had been the productive area for [species *erythraeus*], the west bank producing mainly [species *pygerythrus*] which were rare on the east side. At Mawlaik the east bank again produced [erythraeus], only [pygerythrus] occurring on the western side . . ."

Feeding habits of squirrel species in this subregion have been rarely noted, but Morris (1936, p. 671) recorded that, "At the time the expedition visited the [upper Chindwin River] area the squirrels [of these species] were observed to be feeding on *Elaeocarpus* sp., and *Pterospermum* sp." Although this statement is generalized, *erythraeus*

is the commonest species encountered by the expedition and was evidently meant to be included; the implication is that they fed on the fruits of the trees mentioned.

### ***Callosciurus erythraeus erythraeus* (Pallas)**

*Sciurus erythraeus* Pallas, 1778, *Novae Species Quadrupedum Gliris Ordine* . . . , p. 377.

*Callosciurus erythraeus wellsi* Wroughton, 1921, *Jour. Bombay Nat. Hist. Soc.*, 27., p. 775.

*Types*.—*Sciurus erythraeus*, no longer in existence, the type locality restricted by Bonhote (1901a) to Assam, India, and here further restricted to the Garo Hills of Assam; *wellsi*, BM No. 21.1.6.47, adult male, from Shangpung, 4000 feet, Jaintia Hills, Assam, India, taken July 10, 1920, by H. W. Wells.

*Material examined*, all from Assam, India.—Tura (AMNH), three, (BM), three; Tura Mt., Garo Hills (CNHM), two; Umran (AMNH), five; Nongpoh, Khasia Hills (CNHM), one; Cherrapunji (CNHM), four, (UMMZ), five; Mawryngkueng, Khasia Hills (CNHM), six; "Konshnong," 3000 feet, Jaintia Hills (BM), one, (CNHM) one; Duragiri, 3000 feet, Garo Hills (BM), one; "Mooston," 2000 feet, Khasia Hills (BM), one; "Rajapara," 600 feet, south Kamrup (BM), five; "Kulsi," 150 feet, Kamrup (BM), one; "Shangpung," 4000 feet, Jaintia Hills (BM), one.

*Pelage color*.—The ventral pelage is generally Burnt Sienna (II), but in a few it is Chestnut and at least one Mars Orange. None has the ventral pelage divided, the throats are all red, and the chins remain gray. The tails have the distal half or two-thirds red, some Burnt Sienna, some Mahogany Red. The ears are very bright, Ferruginous (XIV). The feet are very blackish agouti, contrasting rather strongly with the general dorsal pelage color (of back, sides, head, legs and proximal portion of the tail) an agouti of about Citrine Drab (XL). The tail has the same colors below as above.

*Discussion*.—It appears that Blyth (1855, p. 473) identified this subspecies of the Garo Hills and Khasia Hills properly as the red-tailed *erythraeus* of Pallas, 1778, and at the same time distinguished the black-tailed subspecies to the east of it as a new species. These distinctions are perfectly good at the subspecies level in the material available to us. Wroughton's (1921) *wellsi* was described on a single character, a whitish tip to the end of the long red tip of the tail in the typical *erythraeus*. He reported this for only one locality, as constant in a series of nine specimens. As Blyth (1855, p. 473)

had stated much earlier of typical *erythraeus* “. . . the terminal two-thirds or more of the tail are nearly of the same colour as the belly, the tip generally being paler.” Some variation in the amount of this paler tipping is observed in the material, and constancy of excessively pale tips in a sample of nine from one locality, or even a cluster of localities, within the area of general variation is feeble characterization for a subspecies.

CNHM No. 82847 taken at Syndai, 2500 feet elevation, in the Jaintia Hills is black-tailed like *erythrogaster* from the Lushai Hills, although material from other Jaintia Hills localities agrees in every way with *C. e. erythraeus* material from the Garo Hills and Khasia Hills.

### ***Callosciurus erythraeus erythrogaster* (Blyth)**

*Sciurus erythrogaster* Blyth, 1842, Jour. Asiatic Soc. Bengal, **11**, p. 970.

*Macroxus punctatissimus* Gray, 1867, Ann. Mag. Nat. Hist., (ser. 3), **20**, p. 283.

*Callosciurus erythraeus nagarum* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., **24**, p. 228.

*Callosciurus erythraeus kinneari* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., **24**, p. 229.

*Callosciurus erythraeus crotalius* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., **24**, p. 229.

*Types*.—*Sciurus erythrogaster*, IM No. 9262, collected in “Munipore” [Manipur], India, by C. S. Gullevie; *punctatissimus*, BM No. 55.12.24.108, juvenile, from “India”; *nagarum*, BM No. 85.8.1.170, adult male, from near Sadiya, northeast Assam, India, collected in April 1877, by A. O. Hume; *kinneari*, BM No. 15.5.5.79, an old male taken at Tatkon, near Kindat, Burma, west of the Chindwin River on June 26, 1914, by G. C. Shortridge; *crotalius*, BM No. 15.5.5.69, an adult male from Hkamti, 500 feet, on the Chindwin River, in Burma, August 7, 1914, by G. C. Shortridge.

*Material examined*, from Assam.—Aijal, Lushai Hills (CNHM), two; Hnathial, Lushai Hills (CNHM), one; “Syndai,” Jaintia Hills (CNHM), one, (BM), three; Kohima, Naga Hills (CNHM), one, (UMMZ), one; Karong, Manipur (CNHM), one, (UMMZ), one; “Aimole,” Manipur (BM), four; “Machi,” Manipur (BM), two; “Noong-Zai-Dau,” Manipur (BM), one; “Koomberong,” Manipur (BM), one; “Dilkoosha,” Cachar (BM), two; “Cachar” (USNM) one; Margherita, 400 feet, Naga Hills (CNHM), one; 13 miles east of Ledo (USNM), one; Dibrugahr, Rungagora (MCZ), one, (CNHM), one; Mokokchung, 4500–5000 feet (BM), two; Mikir Hills (BM),



one; Tekhubama (BM), two; "Cholimsen," 4000 ft. (BM), one; "Langting," 1500 feet, *Cachar Hills* (BM), one; Takubama, Naga Hills (CNHM), one; Powai [Poi], 400 feet (BM), one.

*Material examined*, all from west of the Chindwin River, Burma.—Mt. Victoria, 1400, 2200, and 2500 meters (AMNH), 16; opposite Homalin (AMNH), one; Tempao (AMNH), one; Pebin (AMNH), one; opposite Moklok (AMNH), one; Nauswa (AMNH), three; opposite Kaungheim (AMNH), 19; opposite Limpa (AMNH), two; opposite Heinsum (AMNH), five; Tanai Hka, Dagung Hka (AMNH), one; Hahti (AMNH), two; "Haingyan," Naga Hills (BM), one; Tatkon, west of Kindat, Chindwin R. (AMNH), one, (CNHM), two, (BM), six; 50 to 65 miles west of Kindat, at 4000 to 5000 feet (BM), three; Tamanthe, 430 feet, upper Chindwin (BM), three; opposite Hkamti, Chindwin R. (BM), eight, (AMNH), one; Hai Bum, Chindwin R. (AMNH), 27; Chenga Hka, Chindwin R. (AMNH), 13; Dagung Hka, Chindwin R. (AMNH), two; Lachu Ga, Chindwin R. (AMNH), one; Taga Hka, Chindwin R. (AMNH), one; Lahkaw Hka, Chindwin R. (AMNH), one; 40 miles northwest of Kindat at 600 feet (BM), one; "Nanthalet," Kawbaw Valley (BM), one; Shingbwiayang, Hukawng Valley (BM), one; 20 miles north of Hkamti (BM), one.

*Type description*.—A color description of the type of *erythrogaster* Blyth, 1842, recorded in 1959 follows: Ventral pelage of body and limbs entirely Mahogany Red excepting for chin which is invaded by agouti. Dorsal pelage a very punctate agouti of about Olive-Brown (XL). The guard hairs of the dorsum generally have two light bands per hair. The bands are a pale buff and one mm. or less in length. The more distal band is generally subapical and 3 to 5 mm. from the proximal light band, and the remainder of the hair is black. The variation in dorsal pelage color is very slight, the feet being blacker but still agouti, and the head very slightly browner. The ears appear to have been faintly redder than the head. The tail is agouti for one-third its length but blackens distally because the black tips of the hairs increase in proportional length. The tail hairs have as many as five light bands on a hair, each about two mm. long and separated about 5 mm. rather evenly. The head gradually lightens anteriorly until the snout and lips are Tawny Olive (XXIX).

*Pelage color*.—The agouti dorsal pelage of back, sides, legs, tail, and head is about Grayish Olive (XLVI) in material from Manipur and the Naga Hills. The feet are slightly darker. The tail is black distally from one-third to all of its length, and in the hills the length



of black seems clinal, least black in the north and increasing southward. The ears are brightest in the Manipur material, Hazel (XIV), but in the Lushai Hills material are about Chestnut Brown. Ventral pelage of body, throat, and limbs is generally all red, but varies slightly: Chestnut (II) in Takubama specimen, Auburn in Kohima one, Mahogany Red from Karong. The series of 16 from Mt. Victoria vary between Mahogany Red and Burnt Sienna. The Takubama specimen, which is from about the middle of the subspecies range, has an agouti throat, and the red ventral pelage is bilaterally divided full length by a 3 mm. stripe of agouti which is as gray as its back. The divided venter seems to occur only occasionally in this subspecies. In the (AMNH) series of 81 specimens from the many localities along the west bank of the Chindwin River only 12 show even a definite incipience of this condition. Proximally the ventral side of tail is like the dorsum in color. The number of black bands on tail hairs seems to range from three (Mt. Victoria) to five (Lushai Hills).

*Discussion*—In this treatment of *erythrogaster* several potential subspecies bearing other names are synonymized with it because they have the distinctive characters of *erythrogaster*. Although they also appear to have small divergent characters of their own, their known geographic range is very limited, and it seems definitely preferable to emphasize their relationship to *erythrogaster* by lumping them with it than to exaggerate their distinctiveness by giving them the same taxonomic rank.

We have seen one (USNM) specimen from Cachar representing the named form *punctatissimus*. Its punctate dorsal pelage is about Bone Brown (XL), its ventral pelage Claret Brown (I). Feet punctate black; digits solid black. Tail black; tail hairs have four light bands obscured by long, black tips. The throat is punctate, and this extends posteriorly as a narrow wedge in the midline. Two specimens from Aijal, Lushai Hills, are similar enough to this to suggest the possibility of a blacker subspecies than *erythrogaster* occupying the monsoon rainforest of the area of west-facing slopes southward from Cachar possibly even along the Arakan Yoma. The large series of ordinary *erythrogaster* from Mt. Victoria appears to mitigate against the existence of such a black subspecies, and there is a good possibility that these very black punctate specimens represent strongly melanistic individual variants in a population of ordinary *erythrogaster*. The problem merits wider collecting.

The named form *kinneari* is known only from Tatkon, and from Ahlaw and Nanthalet in the Kawbaw Valley probably 30 miles to

the west, while from 50 to 65 miles west of Tatkon only ordinary *erythrogaster* (three specimens) are available. Furthermore, the character supposed to distinguish *kinneari* occurs sporadically as an individual variant farther north along the west bank of the Chindwin River: four among 26 specimens from Haibum, four among 19 from opposite Kaunghein, two taken between Jantang and Dagung Hka, and one each at Taga Hka and Lahkaw Hka. Reference to the material listed here and to Carter's (1943, frontispiece) map of these localities will show that more ordinary *erythrogaster* were collected at other localities between the above. This extremely odd *kinneari* character is surely worthy of wider collection and further study, but as now known, it does not appear to characterize a substantially geographic subspecies.

The claim to subspecies status of *crotalius* rests on the distinction of an inconspicuous white tip in the black distal portion of the tail. This is reported to be constant in 29 specimens from the type locality, Hkamti, by the describers of *crotalius*, and Carter (1943, pp. 103 and 110) indicates that it continues constant in occurrence in a sample of 48 more from Hkamti northeastward through seven other localities along the west side of the Chindwin River, a straight-line distance of 42 miles on Carter's (1943, frontispiece) map. See the paragraph beginning this discussion.

The type specimen of *nagarum*, which is from Sadiya, does have a black tail although from (Tate's) color notes it seems otherwise very close to *intermedius* and would, of course, be intermediate between the black-tailed race and *intermedius*. It seems likely that the type of *nagarum* may have come from opposite Sadiya across the Luhit River which for part of its length appears to be a barrier separating the black-tailed subspecies *erythrogaster* on the south from *intermedius* on the north. The type of *aquilo*, also recorded as from Sadiya, was evidently taken beside the Dibong River north of Sadiya, and it agrees in critical pelage characteristics with the type of *intermedius*.

### **Callosciurus erythraeus bhutanensis** (Bonhote)

*Sciurus erythraeus bhutanensis* Bonhote, 1901, Ann. Mag. Nat. Hist. (ser. 7), 7, p. 161.

*Callosciurus crumpi* Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 425.

*Types*.—*Sciurus e. bhutanensis*, skull BM No. 43.8.18.6, skin BM No. 41.1216, "East India Company" collection from "Bhutan";

*crumpi*, BM No. 15.9.1.103, an adult male from Sedonchen, 6500 feet, Sikkim, India, taken on November 17, 1914 by C. A. Crump.

*Material examined*.—Lingtam, Sikkim (CNHM), four; Sedonchen, Sikkim (BM), three.

*Pelage color*.—The ventral pelage is all agouti, but there is a red suffusion in it which demarks the midventral division common in some other forms of *erythraeus*. The rostrum is all Cinnamon Rufous (XIV). The tail has a black tip. The feet are blackish agouti. The ears have a little orange color. The dorsal pelage is between Deep Olive (XL) and Olive Brown. The tail hairs have black tips and four black bands.

*Discussion*.—It now appears from the type descriptions of *bhutanensis* and *crumpi* that the type of *bhutanensis* may be an intergrade between *erythrogaster* and "*crumpi*." It is unfortunate (but not rare) to have the type locality in an area of intergradation. In this instance the type specimen has the red face which characterizes its race but has a venter like that of *erythrogaster*.

Robinson (1913, p. 89) recorded two specimens from Pasighat on the west bank of the Dihang at about 28° 05' north latitude as of this subspecies. One of two other specimens taken about 12 miles west of Pasighat in the Abor Hills he identified as *erythrogaster*, the other he thought intermediate between *erythrogaster* and *intermedius*. There is an island in the Dihang River at Pasighat and much braiding immediately downstream which might well have functioned to disconnect pieces of land inhabited by *intermedius* from the east side of the main stream and eventually connect them with the west side, thus accounting for the presence of the above-mentioned intermediate. Robinson (1913, p. 89) also reported a series of seven *intermedius* from Kobo, which is on the plains just across the island-laden Dihang from Sadiya, which may represent a population that has reached the west side in this same fashion (or may actually have been collected from a population on an island near Kobo).

The presence of *erythrogaster* in the Abor Hills north of the Brahmaputra River seems a piece of zoological evidence which supports the theory that the Dihang was formerly tributary to the Chindwin River (see Chhibber, 1934, p. 33) and that there was no great river barrier between the Abor Hills and the Naga Hills range of *erythrogaster* until the Brahmaputra extended its headwaters and diverted the Dihang to its own channel.

*Habits*.—Crump's field notes and speculations are worth quoting: "Found in heavy forest, singly or in pairs. When alarmed



it usually makes for ground, it was also observed to come down in the evening, so probably it breeds in holes among the roots of trees. The call is a deep-toned clack rapidly repeated. I saw this squirrel only at Sedonchen." (C. A. Crump *in* Wroughton, 1916a, p. 487).

### **Callosciurus erythraeus intermedius** (Anderson)

*Sciurus gordonii*, var. *intermedia* Anderson, 1879, Zool. Anat. Res. Yunnan, p. 241.

*Callosciurus castaneiventris aquilo* Wroughton, 1921, Jour. Bombay Nat. Hist. Soc., 27, p. 601.

*Types*.—*Sciurus gordonii intermedia*, IM No. 9260, a male from Dikrang Valley, Assam, India, taken by H. H. Godwin-Austin (type selected by H. C. Robinson, 1918, p. 198 footnote); *aquilo*, BM No. 20.6.7.19, adult female, from Dibong River, 500 feet, Sadiya, northwest Assam, India, collected November 30, 1919, by H. W. Wells.

*Material examined*, from Assam.—Sadiya (AMNH), two; Dreyi, 5140 feet (AMNH), two, (BM), two; Tezu, 648 feet (AMNH), two; Dening, 2250 feet, Mishmi Hills (CNHM), two, (BM), nine; Rajapara, 600 feet, south Kamrup (BM), eight; "Lonit Valley," 800 feet, Sadiya (BM), one; "Tiki," 1440 feet, Mishmi Hills (BM), one; "Ain," 1500 feet, Mishmi Hills (BM), one.

*Material examined*, from upper Burma.—Nam Tamai, 3000 and 4000 feet, N. Myitkyina Province (USNM), two, (BM), eight; Nam Tamai Valley, 3500 and 6000 feet (CNHM), three; Adung Valley, 5000 feet (CNHM), one; Hkamti Plain, 1500 feet, Kachin Province (CNHM), two; 10 miles E. of Hkamti Plain, 4000 feet (CNHM), one; Sumpura Bum, 2500 feet (CNHM), one; Kadrangyong, 2000 feet, 75 miles north of Myitkyina (BM), one; Htinenan [Htingwan], 3200 feet (BM), one; Lungkhong, 3000 feet (BM), two; Matsatap, 3500 feet (BM), one; Yungtang, 4500 feet (BM), one; Sumka Uma, 2000 feet (BM), one; Taron Valley, 4000 feet (BM), one; Ratnamhti, 2500 feet (BM), one.

*Type description*.—A description made of the type in 1959 follows: Ventral pelage Mahogany Red except for throat which is agouti but partially infiltrated by the reddish color. The reddish agouti extends as a midventral wedge the length of the thorax. The throat, anteriorly where not infused with red, is Citrine Drab (XL). The muzzle is about Isabella Color (XXX). The tail seems about the same color ventrally as dorsally, grossly Cinnamon-Brown. Proximally the dorsum of the tail is, like the middorsum, just about Russet. The middorsum color extends to the rostrum but the red

decreases anteriorly. Dorsal pelage of sides and legs Buffy Brown (XL). Digits all blackish agouti, about Mummy Brown (XV). Dorsal guard hairs have two reddish buff light bands each fully two mm. long and separated by a three mm. black band. Tips black. Tail hairs have reddish buff tips and four blackish bands. Ears and obscure eye-ring about color of muzzle. Tail not perceptibly distichous below.

*Diagnosis.*—The subspecies *intermedius* differs from *michianus* to the east principally in having the middorsal agouti pelage infused with reddish instead of black. Further, the ventral aspect of the tail of *michianus* is notably lighter than that of *intermedius*. The subspecies *intermedius* differs from *gordoni* by lacking the incipient black tip of tail which characterizes *gordoni*, by usually lacking the agouti throat and even a partial agouti stripe like that which entirely bisects the red venter longitudinally in *gordoni*, and by ordinarily possessing red ventral pelage extending to the very heel of the manus rather than red pelage separated from the manus by a centimeter or two of agouti as in *gordoni*. The differences between *intermedius* and *erythrogaster* and *bhutanensis* have been stated in the treatment of those subspecies.

*Discussion.*—The characters of the material representing *Callosciurus sladeni vernayi* (Carter, 1942), appear to represent intergradation between what has been lately known as *Callosciurus sladeni rubex* and *Callosciurus erythraeus intermedius*. The evidence is this: The tail in subspecies *sladeni* (= *rubex*) has a long red tip very much as in subspecies *erythraeus*, but between the ranges of *intermedius* and *sladeni* from N'bunghku to Dalu the Vernay-Hopwood expedition collected this "*vernayi*" material with a plain, agouti tail like that of *intermedius*. The pes and manus are not as entirely red as in *sladeni*, but are invaded by agouti in varying amounts suggesting influence of the all agouti foot of *intermedius*. The amount of reddish in the pelage of the dorsum is intermediate between that of *intermedius* and *sladeni*. The scarcity of occurrence in *intermedius* of a midventral agouti stripe bisecting the red ventral pelage (despite the geographic location of this subspecies between other subspecies characterized by such a stripe—*bhutanensis* to the west and *michianus* and *gordoni* to the east) suggests that *intermedius* receives by interbreeding with *sladeni* the hereditary factor(s) for undivided venter which prevail(s) throughout the forms previously regarded as constituting the species *sladeni*.



The color of the dark, black-tailed *erythrogaster* on the west side of the Chindwin River contrasts strikingly with the light or red-tailed subspecies on the east side. This extreme degree of difference indicates that these squirrels on the two sides of the Chindwin River have been effectively prevented from mingling and interbreeding for a long time. Where the Chindwin is a large and substantial river, and to an unknown extent crocodiles may augment its effectiveness as a barrier to passage of tree squirrels, the river barrier seems a good enough explanation of the observed differences. Up where the river narrows near its headwaters, however, the striking difference continues. At Dalu, the point farthest up-river (north) from which the Vernay-Hopwood expedition obtained squirrels of this species on both sides, *sladeni* shows definite intergradation with the grayer northern subspecies *intermedius*. But *sladeni* shows not the slightest evidence of intergradation with the strikingly different *erythrogaster* across, or around the head of, the river.

In "The Geology of Burma" Chhibber (1934, p. 33) reports and illustrates a geologically earlier condition in which the Tsangpo River of Tibet flowed eastward into the Dihang River of Assam, which flowed southward into the Chindwin River of Burma. The principal physiographic changes which need to have taken place subsequently to reach present conditions are: 1. the head erosion by the Brahmaputra River of Assam, India, to capture the Dihang and its tributary Tsangpo; 2. sufficient uplift to account for a divide with the least elevation of 900 meters presently between the Dihang-Brahmaputra and the Chindwin drainages. The supposed enormously greater former length and volume of the Chindwin River would have provided so impassable a physiographic barrier to spread by tree squirrels, as to permit the observed differentiation of the species *erythraeus* on the east and west sides of the river in Burma. The known distribution of *erythrogaster* remains nicely west of the supposed former connection between the Dihang and the Chindwin, and shows no evidence of intergradation with *intermedius* even though the supposed former barrier is not there now. This may be evidence for recognizing them as separate species, but no specimens of *intermedius* from closer to the supposed former barrier than 60 or 70 miles have been examined, and a narrow zone of intergradation may exist. Suggestion that intergradation probably does occur here is seen in the degree of difference in pelage color characteristics which is greater between *intermedius* and *sladeni* (which are shown above to be connected by intergrades) than between *intermedius* and *erythrogaster*.

The observed geographic differentiation in the squirrel species *Callosciurus erythraeus* thus supports the hypothesis that the Tsang-po-Dihang formerly was part of the Chindwin River. It would be interesting in this connection to know to what extent the population of the species *C. erythraeus* which certainly must exist in Assam north of the Brahmaputra River (in the Dafia Hills, the Miri Hills, and especially the Abor Hills) has differentiated from the population south of that river (*erythrogaster*) since they were effectively separated by this stream piracy.

*Habits*.—Field observations of subspecies *intermedius* are contributed in a letter of June 10, 1961, by Lord Cranbrook from his field notes on the Adung Valley expedition. "No. 63. Shot about 20 feet up in low jungle. No. 56 low down in bushy tree. Nos. 74 and 75. I watched them for a considerable time chasing each other about in the same few trees in fairly heavy jungle. Three times in a period of about  $\frac{3}{4}$  hour they came right down onto the ground, coming down slowly bit by bit and when on the ground constantly alert, running towards or even a foot or two up a tree at the slightest hint of danger, even the chattering of a babbler. These squirrels are very common. By sitting quite still almost anywhere in the jungle one can nearly always see one within half an hour at the longest. If alarmed they freeze for minutes at a time, often in what appear to be the most uncomfortable positions. Not bad eating. Dec. 30, 1930. Crossing the ridge between the Thi Hka and Nam Tisang [see Cranbrook's itinerary in Kinnear (1934)] *C. erythraeus* seen at 5000 feet. Jan. 7, 1931. Nam Hat-Nam Tamai divide. Several *C. erythraeus* seen at 4 to 5000 feet and two collected, so they must be common. The valleys of the Nam Tisang and Nam Hat are very damp; full of leeches and blister flies which may account for not having seen any squirrels in them. The Hkampti Plain where they were very common is comparatively dry at this time of year. No. 147 pregnant January. Common in Nam Tamai valley."

### *Callosciurus erythraeus sladeni* (Anderson)

*Sciurus sladeni* Anderson, 1871, Proc. Zool. Soc. London, 1871, p. 139, pl. 20.  
*Sciurus kemmisi* Wroughton, 1908, Ann. Mag. Nat. Hist. (ser. 8), 2, p. 491.  
*Sciurus sladeni rubex* Thomas, 1914, Jour. Bombay Nat. Hist. Soc., 23, p. 198.  
*Sciurus sladeni midas* Thomas, 1914, Jour. Bombay Nat. Hist. Soc., 23, p. 198.  
*Callosciurus sladeni vernayi* Carter, 1942, Amer. Mus. Novitates, no. 1208, p. 1.

*Types*.—*Sciurus sladeni* (not seen) IM No. 9371, a male taken at Thizyain [Tigyaing], Burma, on the upper Irrawaddy River Jan-

uary 18, 1868, by John Anderson (according to Robinson and Kloss, 1918, p. 201); *kemmisi*, BM No. 8.8.17.3, adult female (skull missing), from Katha, upper Irrawaddy, Burma, collected by A. W. Kemmis; *rubex*, BM No. 14.4.37, adult male, from Lonkin, Myitkyina District, north Burma, collected February 22, 1914 by F. E. W. Venning (Ellerman and Morrison-Scott, 1951, p. 482, proposed to change this to Yin on the Lower Chindwin River, asserting that the animal does not occur at Lonkin. Yet the Vernay-Hopwood Expedition brought back two, AMNH Nos. 113235 and 113241, from Lonkin, collected in January. The face in one is clear orange red as in Thomas' type, that of the other much more grizzled); *midas*, BM No. 11.7.31.1, old male, from Myitkyina District, 600 feet, north Burma, collected May 2, 1911 by A. W. Kemmis; *vernayi*, AMNH No. 113252, adult female, from Tapa Hka, northwest of Myitkyina, north Burma, collected February 2, 1935, by Vernay-Hopwood Chindwin Expedition.

*Material examined*, all from east of the Chindwin River, Burma.—Yin (BM), eight; opposite Kalewa (AMNH), six; Taukchandmai, 500 feet, 20 miles SE of Kindat (BM), one; opposite Mawlaik (AMNH), four; Kindat, 250 feet (BM), 11; Pantha (AMNH), one; Wuntho (BM), one; Katha, 1000 feet (BM), one; "Changzon," 1000 feet, Shweli River (BM), one; "Nyoung Bintha," left bank of Irrawaddy River (BM), one; "Myitkyina District," 600 ft. (BM), one; "Kadranyang," Fort Hertz Road (BM), one; Nanyaseik (AMNH), 10; Lonkin (AMNH), four; Tawmaw (AMNH), four; Mansum (AMNH), one; N'bunghku (AMNH), two; Pumsin (AMNH), four; Zaulep Ga (AMNH), one; Tapa Hka (AMNH), four; Dalu (AMNH), two.

*Discussion*.—The medium-sized tree squirrels occupying the physiographically varied area in upper Burma which lies between the Chindwin and Irrawaddy rivers, show extreme variation in pelage characters which is unquestionably geographic. They also possess two pelage characters which show them to be, so far as noticed, more closely related to each other than to medium-sized squirrels outside of this area. The pelage characters linking these squirrels together are: rostrum and forward part of crown colored like feet; dorsal color of manus continuing onto the forearm for half the forearm length. These characters, we presume, have led some earlier students, not unjustifiably, to consider these squirrels a single species, *Callosciurus sladeni*, and to regard, often with equally good justification, its geographical variants as subspecies. In the account of *C. erythraeus intermedius*, however, we have reported evidence that *sladeni* inter-



grades with *intermedius*, and we therefore recognize the old species *sladeni* as a series of subspecies of *erythraeus*.

Between subspecies *sladeni* and *haringtoni* a related complex of squirrels occupies a curved, band-like area hemming the nearly white subspecies *haringtoni* against the Chindwin River. Within this band there is some justification for the naming of material from the south *millardi* as a subspecies distinct from the northern *shortridgei*, but *bartoni* is intermediate between them in color of pelage as well as geographically. In the American Museum material, no very real justification is seen for the distinction of *careyi* from *fryanus* or *fryanus* from *shortridgei*. Furthermore, it would unnecessarily confuse the more important relationships to accept fragmentation of the squirrels of this band-like area into two or more subspecies, even on a north-south basis, unless it could be demonstrated that the Uyu River or some other partial barrier causes a fairly sharp break in the intergradation of their pelage characters. The important relationships of this band are that it intergrades with *haringtoni* on the west and with *sladeni* on the northeast and south. Every pelage character of the *bartoni* complex is either intermediate between *haringtoni* and *sladeni* or is also possessed by either *haringtoni* or *sladeni*. Table 5 shows some indication of this intergradation.

Table 5 lists the localities at which the Vernay-Hopwood Expedition collected specimens of the squirrel that has earlier been regarded as the species *sladeni*. These localities are distributed in the table in a manner roughly approximating their geographic distribution, the top of the table representing north, the bottom south. The eastern localities in the upper part of the column, however, are actually distributed along a line of march which is grossly northwest from Nanyaseik to Tapa Hka, and the other series extends in a line almost southwest from Dalu to Kalewa (Carter, 1943, map frontispiece). Because the eastern localities are all somewhat equidistant from the more southern Chindwin localities, their relative northernness may be taken as approximating that of Dalu for purposes of the table.

The distances given in Table 5 are approximate airline miles (taken from Carter's 1943 frontispiece map) for the distance between each locality and the one above it. Where two figures are given separated by a comma in the table, both numbers of bands were found, and the first number predominated. Ten to twenty hairs were plucked from the mid-sagittal parts of the body pelage (indicated in Table 5) of each specimen and their color bands counted

TABLE 5. Variation in number of color bands on hairs of named forms at collecting stations of Vernay-Hopwood expedition. (Data are for *black* bands on tail hairs, *light* bands on other. Detailed explanation in text.)

miles	Eastern localities	named forms	tail	rump	back	nape
	Tapa Hka	<i>vernayi</i>	5	3, 4	2, 3	2, 3
10	Pumsin	<i>vernayi</i>	5	3	2, 3	2, 1
5	N'bunghku	<i>vernayi</i>	5	3, 2	2	2, 1
10	Mansum	<i>rubex</i>	5	3	3, 2	2, 1
6	Tawmaw	<i>rubex</i>	5	3, 4	3	3, 2
6	Lokin	<i>rubex</i>	5	3	3	3, 2
15	Nanyaseik	<i>rubex</i>	5	3, 4	3	3
	Chindwin localities					
	Dalu	<i>vernayi</i>	5	3	3, 2	3, 2
39	S. Hkamti	<i>shortridgei</i>	4	3	2, 3	2, 1
9	Heinsum	<i>shortridgei</i>	4	2	2	2, 1
7	Limpa	<i>shortridgei</i>	4	2, 3	2	2, 1
14	Kaunghein	<i>fryanus</i>	3	2, 1	2, 1	2, 1
6	Moklok	<i>fryanus</i>	3	2, 1	2, 1	2, 1
9	Phawzaw	<i>fryanus</i>	3	2, 1	2, 1	2, 1
14	Tamanthe	<i>careyi</i>	0	1	1	1
14	Hulaung	<i>haringtoni</i>	0	1	1	1
9	Maungkan	<i>haringtoni</i>	0	1	1	1
7	Kawya	<i>haringtoni</i>	0	1	1	1
73	Pantha	<i>sladeni</i>	4	3, 2	2, 1	2, 1
18	Mawlaik	<i>sladeni</i>	5	3	2, 3	2, 1
28	Kalewa	<i>sladeni</i>	5	3, 4	3, 2	2, 3

under magnification. Bands on tail hairs were counted *in situ* about at the midlength of the tail. Each locality is represented by one specimen, selected from the available material for having tail hairs fully grown out and dorsal pelage fresh and unworn.

With the aid of the above explanation of Table 5, indications may be seen that the number of bands in the hairs decreases from the *sladeni* (= *vernayi* = *rubex*) material in the north through the northern extremity of the *bartoni* (= *shortridgei* = *fryanus* = *careyi*) band to *haringtoni*. Continuing southward from *haringtoni* through the southern extremity of the *bartoni* (= *millardi*) band, which is regrettably not represented in the Vernay-Hopwood Expedition collection, to *sladeni* again one finds the number increased.

By this lumping, which may seem crude in view of the striking characters involved, one emerges with an understandable, if somewhat hypothetical, distributional variation in the forms of what has



been regarded as the species *sladeni*. For an airline distance of 22 miles along the Chindwin River the astonishingly light, cream-colored form *haringtoni* is known to occur. Although the Chindwin River axis of its range may eventually prove to be somewhat greater than 22 airline miles, the latitudinal axis of its range does not extend directly east more than 22 miles beyond the Uyu River. This range is extremely small for a form accepted here as a good geographic subspecies, but this is one of the most strikingly distinct subspecies in the whole retinue of the greatly variable species *erythraeus*. Surrounding *haringtoni*, together with the Chindwin River, is the subspecies *bartoni* which forms a band probably no more than 40 miles wide and 150 long. The squirrels of this band are variable but certainly not variable enough geographically to justify their fragmentation into the five named forms. Outside of the band which is *bartoni* lies the subspecies *sladeni*. This occupies the suitable habitat of the remaining area between the Chindwin and Irrawaddy rivers. Subspecies *sladeni* is variable also, but the variation observed in it that is geographic does not justify retention of the five named forms.

### **Callosciurus erythraeus bartoni** (Thomas)

*Sciurus sladeni bartoni* Thomas, 1914, Jour. Bombay Nat. Hist. Soc., 23, p. 198.

*Callosciurus sladeni shortridgei* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 232.

*Callosciurus sladeni fryanus* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 232.

*Callosciurus sladeni millardi* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 233.

*Callosciurus sladeni careyi* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 233.

*Types*.—*Sciurus s. bartoni*, BM No. 14.6.18.1, old female, from Uyu River, 900 feet, 20 miles northwest of Mansi, upper Burma, collected March 24, 1911 by C. S. Barton; *shortridgei*, BM No. 15.5.5-104, adult female, from Hkamti, Upper Chindwin River, north Burma, collected July 28, 1914 by G. C. Shortridge and S. A. Macmillan; *fryanus*, BM No. 15.5.5.117, young female, from Munsin, 450 feet, upper Chindwin River, north Burma, collected August 14, 1914, by G. C. Shortridge and S. A. Macmillan; *millardi*, BM No. 15.5.5.136, old male, from Paungbyin between Kindat and Homalin, upper Chindwin River, north Burma, collected June 21, 1914 by G. C. Shortridge and S. A. Macmillan; *careyi*, BM No. 15.5.5.121, old female, from Tamanthe, 430 feet, upper Chindwin River, north

Burma, collected August 16, 1914, by G. C. Shortridge and S. A. Macmillan.

*Material examined*, all from east of the Chindwin River, Burma.—Pyaungbyin (BM), two; Intha, Chindwin River (BM), two; Manthe (AMNH), one; Tamanthe (AMNH), one, (BM), four; Phawzaw (AMNH), four; Minsin, 450 feet (BM), four; Moklok (AMNH), two; Kaunghein (AMNH), 26; Kauktaung, 475 feet (BM), two; Limpa (AMNH), three; Heinsum (AMNH), four; Singkaling Hkamti (AMNH), 40, (BM), 11, (CNHM), two.

*Diagnosis*.—The characteristics distinguishing this admittedly heterogeneous subspecies from its geographic neighbors are: (1) The dorsal pelage of rostrum and feet are not red as in *sladeni* but vary from buffy to whitish. (2) The tail may be agouti or ochraceous to buffy but not white like that of *haringtoni* and its distal portion is not red like that of *sladeni*. (3) The dorsal pelage may be agouti or may vary about Ochraceous-Buff (XV) in those intergrades with *haringtoni* which have been called *careyi*, but differs in being thus tonally much darker than *haringtoni*, the dorsal pelage of which varies about Pale Ochraceous-Buff.

*Discussion*.—The type specimen of *bartoni* is actually intermediate between what is recognizable as the subspecies *bartoni* and *sladeni*, possessing a red tail as it does. The geographic area occupied by *bartoni*, described in the discussion of *sladeni* as a "band" about the range of *haringtoni*, may be a very thin band along the Uyu River. Conceivably, the Uyu may for part of its mid-length actually separate *haringtoni* directly from *sladeni*. Should further collecting prove this to be the case, the subspecies *bartoni* as we recognize it here will then have to be redefined as two separate subspecies, one northeast of *haringtoni*, the other south of it. See the discussion of subspecies *bartoni* in the account of subspecies *sladeni*.

### **Callosciurus erythraeus haringtoni** (Thomas)

*Sciurus haringtoni* Thomas, 1905, Ann. Mag. Nat. Hist. (ser. 7), 16, p. 314.

*Callosciurus solutus* Thomas, 1914, Jour. Bombay Nat. Hist. Soc., 23, p. 199.

*Types*.—*Sciurus haringtoni*, BM No. 5.8.11.1, juvenile male, from Maungkan, 25° N., 420 feet, upper Chindwin River, north Burma, collected December 14, 1904, by H. H. Harington; *solutus*, BM No. 5.8.11.2, male (no skull), from Homalin, upper Chindwin River, north Burma, collected January 2, 1905, by H. H. Harington.

*Material examined*, all from the east bank of the Chindwin River, Burma.—Hulaung (AMNH), four; Maungkan (AMNH), 20 topo-

types, (BM), five; Kawya (AMNH), 12; Homalin (AMNH), 11; (BM), eight, (CNHM), two.

*Original description.*—The type description applies so well in this subspecies to subsequently obtained material that we quote at length from it: "General colour of upper [pelage] 'cream-buff' along the dorsal area, the buff fading out on the sides, which are dull whitish. Individually the hairs of the back are whitish grey basally, with a broad cream-buff subterminal band and a minute black point. Head creamy whitish, with a slight buffy suffusion on the crown; the cheeks dull white. Ears whitish, both outside and in. [Ventral pelage], from chin to anus, bright sharply contrasted ochraceous buff (in the type; the second specimen nearer tawny ochraceous). Lateral line of demarcation [between dorsal and ventral pelage] very sharply marked in both specimens, and in the type emphasized by a blackish line which runs from the middle of the front of the forearm, across the shoulders, down the sides and legs to the back of the heel. Fore limbs on outer side above this line of demarcation creamy whitish, like the flanks; beyond it, including the hands and the whole of the inner aspect, ochraceous buffy like the belly, or slightly paler. Back of upper part of hind leg whitish like body; inner side, ankles, and feet buffy like belly, rather paler on the digits. Tail above and below creamy buff proximally (the extreme tips of the hairs blackish), lightening to white terminally."

*Discussion.*—In the large American Museum series only eight have the black lines which demark separation between the dorsal and ventral pelage really strongly developed; 29 of the specimens have them weak and indistinct; and in 12 the lines are absent. All these specimens were collected between March 20 and 27, and this does not appear to support Thomas's prediction that the presence or absence of the black line is likely to prove to be a seasonal phenomenon. The ventral pelage varies extremely in color from one individual to another in this subspecies (the color of the different parts of the ventral pelage is remarkably uniform in any one individual), and the color of the dorsal pelage of the feet follows the variation of the ventral pelage in each individual.

*Habitat.*—G. C. Shortridge (*in* Wroughton, 1916b, p. 293) comments as follows on the ecology of the vicinity of Homalin inhabited by *C. e. haringtoni*: "On the East bank. The jungle here changes completely and appears to be a curious kind of rather open, not very high, deciduous jungle with stretches of "kaing" grass. Country flat and swampy . . ."

Morris (1935, p. 667) gives more details from McCann's field notes. Between Hulaung and Maungkan, "All along the eastern bank were a number of beautiful *Bauhinia* trees in flower." And at Homalin, more extensive observations, "The forest on the east bank is composed of small deciduous trees among which are *Careya arborea*, *Holarrhena antidyenterica*, *Feronia*, *Dillenia pentagyna*, *Zizyphus*, *Ficus glomerata* and other species of figs, also *Congea*, *Bombax*, *Combretum*, *Elaeocarpus* and a large species of *Smilax* which was in flower. . . . In the evergreen patches bordering the reservoir and stream the following were noticed. . . . The deciduous forest contained large numbers of a species of *Erythrina* . . ."

### ***Callosciurus flavimanus* (Geoffroy St. Hillaire)**

*Definition.*—The species *Callosciurus flavimanus* includes the subspecies *quinquestriatus*, *gordoni*, *shanicus*, *michianus*, *zimmeensis*, *thai*, *atrodorsalis*, *siamensis*, *pranis*, *rubeculus*, *hendeei*, *castaneovenstris*, *flavimanus*, *griseimanus*, *gloveri*, *bonhotei*, *styani*, *ningpoensis*, and *thaiwanensis* and named forms here included in these subspecies. The species *flavimanus* occurs throughout the Indochinese Subregion east of the Sittang and upper Irrawaddy rivers (see fig. 13), excepting the areas of Thailand and Cambodia and part of Laos along the Mekong, where the species *finlaysoni* occurs.

*Diagnosis.*—In this extremely variable species no pelage or other characters have been found which distinguish all of its subspecies from all of the subspecies of its closest relatives. Table 6 provides body and skull dimensions of some types included in this species.

*Relationships to other species.*—This discussion evaluates the evidence for recognizing the species *Callosciurus flavimanus* to have the geographic range, and to include the subspecies shown in fig. 13. To follow it the reader will need to make constant reference to that figure and possibly some reference to the Classification provided near the beginning of the paper. Inasmuch as great rivers are seen to be barriers to tree squirrels in the Indochinese Subregion, the most likely place to look for evidence of intergradation between *Callosciurus erythraeus* west of the Irrawaddy River with some form of its closest relative across the river would be as far up the river as the squirrels occur. There the narrower river would be less of a barrier, and it seemed fair to ask whether even at 28° latitude the elevation might permit ice to bridge the river in enough places often enough to keep up genetic exchange between the populations on opposite sides of the river. Lord Cranbrook, who collected birds and mam-



mals in the Nmai Hka headwaters of the Irrawaddy in 1931, comments (letter of May 5, 1961) on this: "The Nam Tamai and Adung are both headwaters of the Nmai Hka, and there were no snow bridges until about 7000 or 8000 feet on the Adung, at which point squirrels could have crossed on trees." He reached the Adung Valley on January 25th and collected in it about Tahawndam until May when the snow melted back enough to let his expedition go farther up the valley (Cranbrook, *in* Kinnear, 1934, p. 348). Some of Lord Cranbrook's published observations (*loc. cit.*) bear on the present problem, "On the fourth day the [Adung] valley turned to the north and there seemed to be a definite change from typical subtropical hill jungle to forest of a more temperate type. Conifers were quite numerous in the valley bottom. . . . Even the fauna seemed to change, as above this bend I saw none of the red-bellied *Callosciurus erythraeus* which were so plentiful in the . . . lower Adung, and the long-nosed squirrels, *Dremomys pernyi* and *D. [lokria]* seemed to take their place. The next day we arrived at Tahawndam . . ." Since the February and March records of bird specimens (Cranbrook *in* Kinnear, 1934) are consistently recorded as 6000 feet, this is surely the elevation at Tahawndam. In Lord Cranbrook's experience, therefore, the red-bellied *Callosciurus erythraeus* did not range up to the elevation at which snow bridges occurred.

On having seen the above arrangement and implications of his remarks, Lord Cranbrook (letter of June 25, 1961) expressed doubt that the Adung River is a barrier to squirrels even below 6000 feet. He then adds: "I think, though, that it is reasonable to assume that the climate in the Adung Valley has become less rigorous fairly recently. The glacier from which the river rises was obviously in retreat, with a long, convex snout, and the appearance of the valley below it made Kingdon Ward think that the retreat had been pretty rapid. The glaciers from which the Taron rises, the other side of the Namni La, were also in retreat and that valley too showed signs of recent ice action. If there had been much more ice and snow at the head of the comparatively short valley of the Adung and also at the head of the even shorter valley of the Seingku, the *Callosciurus-Dremomys* boundary . . . might well have been pushed further south to a point where the Tamai was in fact a barrier."

Downstream *C. erythraeus sladeni* opposes the forms *C. flavimanus gordonii* and *C. f. shanicus* across the Irrawaddy River, and there is no hint from the material reported herein from American museums, of direct genetic exchange between *sladeni* and either of





these other two. To the north of *sladeni* the subspecies *C. e. intermedius* occupies the region about 200 miles wide between the Brahmaputra's north-south course and the Irrawaddy's eastern fork the Nmai Hka. Opposite *intermedius* across the Nmai Hka is *quinquestriatus*, which has stood as a separate species because of its extraordinary ventral black and white stripes (Ellerman and Morrison-Scott, 1951, p. 488; Anthony, 1941, p. 89). Since *quinquestriatus* is shown below to intergrade with *gordoni* on the south, it becomes important to consider whether *quinquestriatus* may also intergrade with *intermedius* near the headwaters of the Nmai Hka, or if there is in fact a species level difference between the last two.

The 1938-39 expedition from the American Museum of Natural History to the mountain range between the Nmai Hka and the Salween River, remained south of 26° 30'N. They collected a substantial series of *quinquestriatus* (Anthony, 1941, p. 90), but there the elevation of the barrier river Nmai is apparently less than 700 feet. This is at least 100 miles south of the area where intergradation would be most likely to take place. The area between the barriers of the Nmai and Salween is less than 40 miles wide and suitable habitat for tropical tree squirrels is probably narrowed to somewhat less than that. If other influences for differentiation are the same, one could expect perhaps even greater differences to occur in this narrow 100-mile strip north of the northernmost available specimen of *quinquestriatus* than are now known, and shown below, to occur in the first 100 miles south of the range of *quinquestriatus*. (See fig. 13.)

The similarities in color characteristics of the pelage, then, between American Museum of Natural History material of *intermedius* and *quinquestriatus* are: 1. Generally agouti dorsal pelage of about Dresden Brown (with a reddish suffusion on the middorsum bringing it to about Cinnamon Brown there) over the head, back, tail, sides, legs, and feet. 2. The digits and sometimes the feet are blacker

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FIG. 13. The geographic distribution of two species, the red-bellied squirrel, *Callosciurus erythraeus*, A to G, and the belly-banded squirrel, *Callosciurus flavimanus*, H to Z, as revealed by material examined (except for open dots on Formosa which indicate records from literature). Subspecies of *erythraeus* (west of the Irrawaddy): A, *erythraeus*; B, *erythrogaster*; C, *bhutanensis*; D, *intermedius*; E, *sladeni*; F, *bartoni* (triangles); G, *haringtoni* (squares). Subspecies of *flavimanus* (east of the Irrawaddy-Sittang Valley): H, *quinquestriatus*; I, *gordoni*; J, *shanicus*; K, *michianus*; L, *zimmeensis*; M, *thai*; N, *atrodorsalis*; O, *siamensis*; P, *pranis*; Q, *rubeculus*; R, *hendeei*; S, *castaneiventris*; T, *flavimanus*; U, *griseimanus*; V, *gloveri*; W, *bonhotei*; X, *styani*; Y, *ningpoensis*; Z, *thaiwanensis*.

TABLE 6. Dimensions of Some Type Specimens of the Species *Callosciurus flavimanus*.

NAME	BODY			SKULL						
	Head & Body	Tail	Hind Foot	Total Length	Mas-toid Breadth	Length Nasal	Dia-stema	Length Palate	Length Bulla	Molar Tooth-row
<i>imarius</i>	260 ±	220 ±	58	52.3	23.0	16.2	12.0	25.3	9.3	9.0
<i>gordoni</i>	230 ±	170 ±	46	....	....	15.8	11.4	24.4	...	8.6
<i>shanicus</i>	208	183	52	50.4	21.6	15.2	11.0	24.5	9.8	9.3
<i>haemobaphes</i>	240	155	51	48.7	21.4	14.7	10.2	23.2	10.7	8.9
<i>zimmeensis</i>	217	205	53	53.0	22.3	16.1	11.3	24.8	9.7	9.4
<i>primus</i>	260 ±	240 ±	56	54.9	23.6	17.2	12.0	27.0	10.7	10.1
<i>siamensis</i> <sup>1</sup>	170 ±	180 ±	44	....	....	11.7	9.5	21.6	...	8.2
<i>tachin</i> <sup>1</sup>	206	125	42.5	45.2	18.2	13.7	9.9	21.8	9.0	8.0
<i>pranis</i>	208	193	51	51.5	22.3	16.2	12.0	24.1	9.6	9.2
<i>rubeculus</i>	222	210	55	55.3	24.0	15.0	13.2	28.0	10.2	8.9
<i>youngi</i>	201	195	52	51.2	22.6	14.1	12.0	24.9	9.1	8.9
<i>hendeei</i>	224	213	55	55.0	23.0	16.9	13.3	26.2	10.0	9.4
<i>quantulus</i>	215	205	56	54.4	23.2	15.5	12.2	26.0	10.2	9.3
<i>dactylinus</i>	232	223	55	53.9	23.3	16.7	11.9	26.8	9.9	10.2
<i>contumax</i>	220	228	54	55.8	23.9	16.7	12.5	27.5	10.3	9.8
<i>pirata</i>	232	200	56	53.2	23.0	...	12.1	25.9	10.2	9.9
<i>bolorensis</i>	244	208	55	54.0	23.0	15.7	12.5	26.0	10.5	9.5
<i>griseimanus</i>	240 ±	220 ±	52 ±	....	....	16.1	12.8	26.3	...	9.6
<i>phanrangis</i>	217	140	46	48.7	20.7	15.8	10.2	23.3	9.6	9.0
<i>gloveri</i>	210 ±	220 ±	51	50.2	22.4	15.6	10.1	23.8	9.5	9.5
<i>styani</i>	220 ±	110 ±	50	48.0	20.7	14.4	10.9	24.0	9.7	9.1
<i>canigenus</i>	194	155	51	49.6	22.0	14.4	11.1	24.0	9.8	9.2
<i>woodi</i>	355 <sup>2</sup>	242 <sup>2</sup>	50	48.7	21.7	15.7	11.5	24.9	10.0	9.0
<i>thaiwanensis</i>	229	203	..	54.1	23.0	16.2	12.5	25.7	9.8	10.2
<i>centralis</i>	245 ±	200 ±	52	53.0	22.7	16.2	11.6	26.4	9.8	10.0

<sup>1</sup> The types of *siamensis* and *tachin* are young adults.<sup>2</sup> These two measurements are in error on the large side.

agouti than the general dorsal pelage. 3. The agouti guard hairs of the dorsal body pelage have from one to three light bands, generally two, but on some individuals three is common. 4. The tail in ventral view appears scarcely more distichous than in dorsal. 5. There is no pronounced eye ring.

The distinctions in color of the pelage between *intermedius* and *quinquestriatus* are: 1. In five of the six *intermedius* the venter is entirely red (not bisected by a band of agouti), but in *quinquestriatus* the most extreme condition of bisection in the whole subregion occurs. (The bisecting band is black instead of agouti, the divided ventral pelage is white instead of red, and the outer margins of the white are bordered with black.) 2. *C. e. intermedius* has no black tip to the tail, but *quinquestriatus* generally has a large and conspicuous black tip to the tail (which becomes subterminal in some specimens wherein the black terminal hairs are generously tipped with brown). 3. The hairs of the tail of *intermedius* have five blackish bands (additional to a short, black tip), but those of *quinquestriatus* have only four. 4. The ears of *intermedius* are no redder than the pelage of the middorsum, but in *quinquestriatus* the ears are redder than the middorsum (except in the very red specimens from low elevations across the Irrawaddy from Myitkyina). 5. The rostrum and the face below and slightly encircling the eye of *intermedius* is a noticeably cooler gray than the nape, but in *quinquestriatus* these parts are buffier and warmer in color than the nape (again excepting the very red lowland specimens).

The above differences between these two forms are much greater than those between *quinquestriatus* and *gordoni* and even somewhat greater than those between *quinquestriatus* and *shanicus*, the next form south of *gordoni*. Since the differences between *quinquestriatus* and *gordoni* and between *gordoni* and *shanicus* are in both cases very great ones for subspecies in the subgenus *Callosciurus* of this subregion, it appears that the differences between *quinquestriatus* and *intermedius* are too great and the similarities too general for one to presume their relationship to be subspecific.

Since on the basis of degree of difference, forms *intermedius* and *quinquestriatus* evidently represent two species, one should note additionally that a geographic intensification of differences between the two species progresses toward the probable point of most frequent contact. In the eastern species, for which *flavimanus* is the oldest acceptable name, the pelage character which may be called bisected venter is one of the most widespread in the Oriental Region (south



for 1700 miles through six subspecies, east for 1500 miles through five subspecies). In *gordoni* (not far from the range of *intermedius*) it intensifies to its strongest agouti expression. In *quinquestriatus*, closer to the range of *intermedius*, it becomes stronger still by turning to black. Approaching from the south through subspecies *rubeculus*, *pranis*, *siamensis*, *atrodorsalis*, *thai*, *zimmeensis* and *gordoni*, or from the east through *thaiwanensis*, *castaneoventris*, *hendeei*, and *michianus* one finds the rich red venter (divided or undivided). This is similar to the venter of *C. erythraeus intermedius* (and all but one form of *erythraeus*), but upon closest approach to the probable point of latest, or most frequent species contact, in *C. flavimanus quinquestriatus* the red venter is lost and replaced with black and white stripes. This provides extreme contrast with the bright red venter of *intermedius*. Approaching from the west, in *C. e. bhutanensis* one finds the black tail tip, reddish face, reddish ear tips, and divided venter that occur in eastern subspecies of the species *flavimanus*. Moving closer to the probable point of most frequent, or recent, contact between the species, one finds all of these characteristics gone or greatly reduced in *intermedius*.

The above phenomenon appears to be very similar to what has been called "character displacement" (Brown and Wilson, 1956), differing from their definition of character displacement in that there is now no known zone of overlap of ranges of the two species.

It is apparent on examination of the range map (fig. 16) of *Callosciurus pygerythrus* that the former river course of the Irrawaddy-Sittang must have been the eastern barrier to spread by that species, and for the most part, still is today. The Nmai Hka branch of the upper Irrawaddy apparently still is the barrier to eastward spread of *pygerythrus* in the region where the species *pygerythrus* is sympatric with *C. e. intermedius*. Although the Nmai is not shown so large on maps as the Salween, Mekong, or Brahmaputra, it seems likely on the basis of squirrel distribution that it was larger in the past and subsequently lost some of its headwaters by stream piracy. Such a former condition would better explain why the Irrawaddy shows so much evidence of having provided the greatest barrier to east and west spread of tree squirrels in the Indochinese Subregion.

### ***Callosciurus flavimanus quinquestriatus* (Anderson)**

*Sciurus quinquestriatus* Anderson, 1871, Proc. Zool. Soc. London, 1871, p. 142.

*Sciurus beebei* J. A. Allen, 1911, Bull. Amer. Mus. Nat. Hist., 30, p. 338.

*Callosciurus quinquestriatus imarius* Thomas, 1926, Ann. Mag. Nat. Hist. (ser. 9), 17, p. 640.

*Callosciurus quinquestriatus sylvester* Thomas, 1926, Ann. Mag. Nat. Hist. (ser. 9), 17, p. 641.

*Types*.—*Sciurus quinquestriatus*, IM No. 10163, specimen from Pensee, east of Bhamo, Burma, in the Kakhien Hills, taken March 4, 1868, by John Anderson; *beebei*, AMNH No. 32624, adult male, originally described in error as from Sarawak, but fixed by Goodwin (1953, p. 282) as Sansi Gorge, Burma-Yunnan boundary, December 7, 1910, collected by C. William Beebe; *imarius*, BM No. 20.8.-7.6, old male, from west flank of Imaw Bum, Kachin, Burma, latitude 26° 10' N., longitude 98° 30' E., October 21, 1919, by F. K. Ward; *sylvester*, BM No. 25.10.5.31, adult male (skull lost), from the forests of the Shweli-Salween divide, 9000 feet, west Yunnan, China, collected September, 1925, by G. Forrest.

*Material examined*, from northeastern Burma.—15 miles north of Myitkyina on east side of Irrawaddy River (USNM), eight; six miles north of Myitkyina (USNM), one; Porg-ka-tong (AMNH), one; Pum-ka-tong (AMNH), one; between Nomoyoung and Seniku (AMNH), one; between Tamu and Chipwi (AMNH), three; between Chipwi and Laukhauna (AMNH), two; between Tamu and Tanga (AMNH), two; Laukhaung (AMNH), four; Pyepat (AMNH), three; between Pyepat and Langyang (AMNH), two; above Tsonma, 8300 feet (AMNH), one; Gangfang, 5200 feet (AMNH), one; Hkamkawn, 4000 feet (AMNH), one; Hpimaw, 7600 feet (AMNH), two; Htagaw (AMNH), one; Sima, Myitkyina, 4500 feet (BM), three; Sui Kin, Bhamo (BM), three; Teinzo, northeast of Bhamo (BM), two.

*Pelage color*.—Description of Indian Museum Paratype, a stuffed study skin examined in January of 1960: Dorsal pelage agouti of about Cinnamon Brown (XV) on crown, nape and back, but paling on tail and sides to Dresden Brown. Ears in part redder, about Ochraceous Tawny. Feet like back but digits blacker. Tail hairs with blackish tips plus 4 blackish bands, but tip of tail light, about Buckthorn Brown. Agouti dorsal pelage has two distinct light bands and black on the tips and between light bands. Ventral pelage has two longitudinal light stripes, Light Ochraceous Buff from posterior end of throat to anus, separated and bordered by blackish bands (thus making two "white" and 3 "black" stripes) of the same length. The light bands are about 10 mm. wide on the thorax but 5 mm. or less for most of their length. The blackish middle stripe is similarly

wide but the two lateral ones seem narrower. The middle stripe is definitely agouti on the thorax. The "black" stripes seem faded and are only about Prouts Brown. The hind legs are agouti all the way around, definitely, but blackish pelage apparently extends out the ventral surfaces of the fore limbs. The tail has a subterminal black tip.

In the original description Anderson recorded the light stripes as "pure white" and their laterally bordering stripes as black and this black as "expanding on the inside of the thighs." Probably during the intervening 90 years the white has become less white and the black less black, for the American Museum Natural History material agrees emphatically with Anderson's description in these three particulars.

*Discussion.*—At the very beginning of knowledge of this squirrel, Anderson (1871, p. 142) considered it most closely related to [*Callosciurus flavimanus*] *gordoni* and included the two kinds under one common name, "the belly-banded squirrels." Nevertheless, the uniqueness of the five vividly contrasting black and white longitudinal bands of *quinquestriatus* has evidently discouraged all subsequent students down to the present from considering that these two squirrels may be conspecific. There is, however, evidence that their ventral markings possess a common pattern which suggests that the amount of genetic difference between *quinquestriatus* and *gordoni* is not very great.

The following observations are the basis upon which *quinquestriatus* and *gordoni* are here considered conspecific (see fig. 13). The *gordoni* specimen CNHM No. 32519 from 27 miles north of Bhamo has a blackish midventral stripe and incipient black showing in the edge of the agouti of the animal's side where the agouti meets the red of the venter. In *gordoni* specimen AMNH No. 43217 from Hui Yao, Yunnan, the edges of the 7 mm. wide midventral agouti stripe, as well as the ventral edges of the agouti sides of the animal, are blackened. AMNH No. 43217 represents no great departure from the characteristics of *gordoni*, but its midventral stripe is precisely like that of many of the American Museum specimens of *quinquestriatus*. Even the ventral edges of the sides of AMNH No. 43217 would need to become but little blacker to equal the blackness of some examples of American Museum material of *quinquestriatus*. Especially significant among the large series of *quinquestriatus* is AMNH No. 114907 from between Tomu and Chipwi, Burma. This specimen although preponderantly *quinquestriatus* in character ap-



proaches the characteristics of *gordoni* in several ways: (1) The mid-ventral stripe is quite like that described for AMNH No. 43217, and the ventral edges of the sides are only a little blacker. (2) The subterminal black tip to the tail is short and rather subdued. (3) The two ventral stripes which are ordinarily white in *quinquestriatus*, are Apricot Buff (XIV).

The ventral pelage of *gordoni*, thus, may be said to be three-striped, or to consist of a 6 or 7 mm. agouti longitudinal mid-stripe which separates the red of the remainder of the venter into two broader, rather stripe-like, sections. In *quinquestriatus* the midventral stripe is blackened on its edges or sometimes is entirely black. The outer edges of the remaining ventral pelage is black, making two lateral black stripes of a width approximating that of the middle stripe, but including also the entire ventral pelage of the limbs. The remaining two areas of ventral pelage, generally about ten to twelve millimeters wide, are white. Thus, there are characteristically two white stripes intersticed between three black ones.

The dorsal pelage of these two forms differs in but small details. Dorsal pelage of both body and tail is an agouti varying about Buffy Brown (XL) in *quinquestriatus* but is generally less red in *gordoni*. The subterminal black tip of the tail is generally longer in *quinquestriatus*.

No evidence of intergradation between *C. f. quinquestriatus* and subspecies [*C. erythraeus*] *intermedius* or [*C. flavimanus*] *michianus* has reached our attention as such. Probably the Salween River is barrier enough to prevent *quinquestriatus* from intergrading with *michianus* (see fig. 13). It would seem surprising, however, if the Nmai Hka or its northeastern tributary, the Taron River, would long prevent *C. e. intermedius* from coming into contact with *C. f. quinquestriatus*. See discussion above in the account of the species *flavimanus*.

### ***Callosciurus flavimanus gordoni* (Anderson)**

*Sciurus gordoni* Anderson, 1871, Proc. Zool. Soc. London, 1871, p. 140.

*Type*, here designated.—IM No. 9268 a parous female taken at Bhamo, upper Burma, on February 24, 1868, by John Anderson. This specimen is here selected from the two cotypes as the type of *gordoni* because it is adult (whereas the other is not) and is rather typical of the subspecies in ventral color (whereas the other is not).

*Material examined*, all from a small area of northeast Burma and adjacent Yunnan.—Homoshu Pass, 8000 feet (AMNH), one,



(CNHM), one, (MCZ), one; Taipingpu, 7000 feet, Shweli River (AMNH), two, (CNHM), one, (MCZ), one; "Hui Yao," 5500 feet, Tengyueh (AMNH), one; Watien, Tengyueh (AMNH), two; "Yunnan" (AMNH), one; Kyu Loi, S. Shan States (ANSP), one; Shweli-Salween Divide, 7000-10,000 feet (CNHM), two, (BM), twelve; Bhamo, Burma (USNM), one topotype; Momauk, nine miles east of Bhamo (USNM), one; Cuchi, Yunnan (USNM), one; "Linchiapu," Yunnan (USNM), one; Shweli Valley, 9000 feet (BM), two, 8000 feet (BM), eight, 7000 feet (BM), one; hills northwest of Tengyueh, Yunnan (BM), three; "Watan," 5000 feet, Bhamo (BM), five; Machangkai, 6500 feet, Tengyueh (BM), one.

*Type description.*—A description of the type from examination of it in 1959, follows: Ventral pelage Cinnamon Rufous (XIV), but divided all the way down the middle by an agouti stripe 3 mm. to 5 mm. wide. The color of the venter extends over half the length of the throat. The remainder and muzzle are about Isabella Color, and so are circular areas around the four teats (about 10 mm. diameter). Dorsal pelage agouti, paler than Citrine Drab (XL). The sides nicely Dark Olive Buff (XL). Dorsal guard hairs have two buffy bands each  $1\frac{1}{2}$  mm. long separated by a black band  $2\frac{1}{2}$  mm. long. Tips are black. Head, legs, and feet like back. Ears like muzzle. Tail color like dorsum both dorsally and ventrally. Not perceptibly distichous below. Tail hairs have black tips and four black bands 3 mm. to 4 mm. long (and four 2 mm. to 3 mm. light bands and a shorter light base). Tail has short blackish pencil ending in buff tip. Notably, we think, in both cotypes the midventral agouti stripe is most intensely agouti in the stripe's midlength rather than near the throat and in the present specimen, does not reach the throat.

*Discussion.*—This rather well-marked subspecies appears from the material examined to occupy a very small range in northeastern Burma between the Irrawaddy River at Bhamo and the Salween River. Anderson (1879, p. 240) gives an impression of a somewhat greater range when he says, "I have collected about twenty-five specimens of this squirrel from various parts of Burma, north of the capital [Mandalay], . . ." However, it seems doubtful that *gordoni* occurs south of the Shweli River in Burma excepting as an intergrade with *C. f. shanicus*, for *shanicus* is known from several localities northeast of Mandalay along the road and railroad to Lashio.

To the north *gordoni* appears to be replaced rather abruptly by *quinquestriatus*, and evidence of intergradation between the two has

been described above under the discussion of subspecies *quinquestriatus*. Subspecies *gordoni* differs from *richianus* and *zimmeensis* to the east in lacking the incipient black mark on the posterior two-thirds of the middorsum and in possessing a median agouti band which completely bisects the red pelage and which is itself the color of the agouti dorsum. To the south it seems most logical that *gordoni* intergrades with *shanicus* from which it differs by possessing: (1) divided red ventral pelage, (2) a face which is just as dark agouti as its dorsum, and (3) a middorsum which lacks the incipient black on its posterior two-thirds. From subspecies [*C. erythraeus*] *sladeni* to the west across the Irrawaddy *gordoni* differs (so greatly that it is no wonder they have been considered separate species) by possessing: (1) the red venter divided, (2) the feet and rostrum agouti instead of red like the venter, (3) the tail colored like the back instead of extensively red-tipped. Details of the possibility of intergradation with *phayrei* are considered under the species *phayrei*.

### ***Callosciurus flavimanus shanicus* (Riley)**

*Sciurus atrodorsalis shanicus* Riley, 1914, Jour. Bombay Nat. Hist. Soc., 22, p. 662.

(?) *Sciurus griseopectus* Blyth, 1847, J. Asiat. Soc. Bengal, 16, p. 873.

*Types*.—*Sciurus a. shanicus*, BM No. 13.11.18.1, an adult male from Gokteik, 2133 feet, North Shan States, Burma, taken April 23, 1913, by G. C. Shortridge; *griseopectus*, IM No. 9369, a parous female captive from unknown locality, presented in 1847 by Rajah R. Mullick.

*Material examined*, all from Burma.—Maymyo, 800 meters (AMNH), four, (BM), six; Gokteik, 2133 feet (BM), two, (CNHM), two; Pyaunggaung, 2794 feet (BM), four, (CNHM), one; Kawlaw, 4400 feet, west of Taunggi (BM), one; northeast of Hoiparo, N. Shan States (BM), one; Mongha, N. Shan States (BM), one.

*Discussion*.—Specimens of *shanicus* were taken at precisely the same elevations as *phayrei* at three of the same localities (Maymyo, Gokteik, and Pyaunggaung). At Maymyo in 1937 Gerd Heinrich collected six *phayrei* between November 27 and December 25 and a series of four *shanicus* between December 3 and 20. He took one specimen of each form on one of these days (the 20th). Heinrich's four *phayrei* with substantial toothwear have head-and-body length ranging from 222 to 238 mm. Although three of the *shanicus* have substantial toothwear, all have head-and-body length between 200 and 211 mm. These data are quantitatively weak but no indication

is seen in them that *shanicus* is a seasonal or other color phase of *phayrei*. This and the many differences reported in the account of species *phayrei* suggest strongly that they belong to separate species. The form *shanicus* closely approximates *gordoni* in size and will doubtless be shown to intergrade with *gordoni*. The color characteristics of *shanicus* show evidence of relationship also to *atrodorsalis* and *zimmeensis*, but the Salween River probably prevents intergradation. See also comparisons made under *C. p. janetta*.

*Pelage color*.—The two topotypes at Chicago have dorsal pelage of body, legs, feet, head, and tail Grayish Olive and incipient black shows on the posterior two-thirds of the middorsum on both. The abrupt, brief, black tip of tail has whitish tips. The ventral pelage is Old Gold (XVI) in color, and all of it is agouti. The Chicago Natural History Museum specimen from Pyaunggaung agrees with this, and so do the four specimens in the American Museum of Natural History from Maymyo.

*Habits*.—Shortridge's field notes on this subspecies follow: "The most plentiful squirrel in Hsipaw State and around Maymyo, recalling *Funambulus palmarum* of India in its habit of collecting around gungalows. The black mark on the back was seldom conspicuous except in immature specimens." (G. C. Shortridge in K. V. Ryley, 1914, p. 721.)

*Type description*.—Examination of the type of *Sciurus griseopectus* Blyth, 1847, reveals (in 1959) the following characteristics: Ventral pelage Ochraceous-Tawny to Tawny except for agouti throat and a midventral extension from the throat posteriorly halfway to the anus. Throat is Deep Olive Buff (XL). Muzzle and chin are Chamois (XXX), and so is a circular area 10 mm. diameter around each teat. Proximally the tail is lighter beneath, Dark Olive Buff (XL), than above, Deep Olive. Dorsal pelage agouti and entirely about Buffy Brown (XL). The ears are like the muzzle, Chamois. The dorsal guard hairs have two buffy bands each two mm. long and separated by a 2 or 3 mm. blackish band, and have black tips. The tail hairs are brownish buffy tipped and have four black bands. The tail's dull color may be in part due to the hair being old, but probably when fresh it is only a little less dull. The feet look faintly paler than the middorsum, but not paler than the sides. There are barely evident eye rings tending toward Chamois. The tail is not perceptibly distichous below.

*Discussion*.—In the original description of *griseopectus*, Blyth (1847) mentioned two points important to identification of the re-



gion whence the type must have come: the divided red venter, and "the tail being slightly black-tipped, but with pale ends to the hairs." These conditions occur in *ningpoensis*, *michianus*, and *zimmeensis*, as will be shown below, and in *gordoni* as reported above. Strong tendency to feet blacker than dorsum mitigates against all of these but *ningpoensis*. Anderson (1879, p. 239) made something of a case for the type of *griseopectus* having come from China, and placed it in the synonymy of *castaneiventris* Gray 1842. As restricted here, *castaneiventris* has feet too black and tail tip too different. The proper color relationship of foot to dorsum is common in the large AMNH series of *ningpoensis*, but in *ningpoensis* the muzzle and chin are rather consistently cool gray, and the tail hairs have five or even six blackish bands instead of four. In *ningpoensis* also three light bands on a guard hair in the pelage of the dorsum is common, whereas in the type of *griseopectus* the highest number noted was two. In conclusion, the probability of the type specimen of *griseopectus* being from China east of the Salween River seems slight to us, even though the sample of *ningpoensis* is so variable, and even though the area of southern China from which no material representing this species has been available, is extraordinarily large.

When material becomes available from an area of intergradation between *gordoni* and *shanicus*, it seems likely that individuals quite like the type of *griseopectus* may be found among them. The ventral pelage color would be quite intermediate, and *shanicus* could contribute the proper muzzle, chin, ear, and foot color and the correct number of blackish bands on tail hairs and light bands on guard hairs of the dorsal pelage. The favorable *gordoni* influence would be toward browner dorsal pelage and less distichous tail shape. At present writing this identification of *griseopectus* seems more probable than geographic location in eastern China. Until someone can identify material from known localities with the type of *griseopectus*, however, it seems best to let the name *shanicus* stand and to associate *griseopectus* with it only uncertainly.

### ***Callosciurus flavimanus hyperythrus* (Blyth)**

*Sciurus hyperythrus* Blyth, 1855, Jour. Asiatic Soc. Bengal, 24, p. 474.

*Type*.—IM No. 9478, an individual from Tenasserim, presented in 1852 by Major Berdmore.

Ellerman and Morrison-Scott (1951, p. 479) suggest the Sittang Valley as the geographic source of the type.



*Type description.*—The following characteristics of the type were observed by one of us in 1959: Ventral pelage, including that on limbs, is entirely Bay or Claret Brown except for the chin which is infiltrated by agouti and is about Hazel. The dorsal pelage is agouti and is about Light Brownish Olive (XXX). This color is ubiquitous except on the ears and the head forward of the ears, where it merges into Hazel. The short pelage on the rather battered ears is clearly deeper red, about Kaiser Brown or even Hays Russet. There is no eye ring. Dorsal guard hairs generally have two light bands each somewhat exceeding one mm. in length and separated 3 or 4 mm. from each other. The tail hairs have five blackish and five light bands and their tips are blackish on the proximal half of the tail but reddish on the distal half. The tail shows a faint tendency to be distichous beneath.

*Discussion.*—Material representing the species *flavimanus* from lower Burma is so scarce that although we are doubtful regarding whether the type specimen came from the vicinity of the town of Tenasserim or just from somewhere in the province of Tenasserim (which seems from usage to have extended north at least as far as the lower Sittang Valley), it is not possible for us to locate the most probable geographic origin of the type by comparing it with material from various parts of Tenasserim. In any case the type locality is certainly not Moulmein as questioningly suggested by Robinson and Kloss (1918, p. 199) unless they would wish to imply across the Salween River, for Moulmein is designated type locality for *C. f. atrodorsalis* and has proven to be quite acceptable as such. Martaban across the Salween would be a perfectly acceptable type locality, but not necessarily any better than the Sittang Valley 70 miles farther north. However, until specimens become available for study from these places it must be left a little uncertain where the type locality of this named form is, and if it is in fact a subspecies, where its whole range may be. Burma between the Sittang and the Salween seems the most reasonable possibility, but it remains to be proven.

***Callosciurus flavimanus michianus* (Robinson and Wroughton)**

*Sciurus castaneiventris michianus* Robinson and Wroughton, 1911, Jour. Fed. Malay States Mus., 4, p. 234.

*Sciurus castaneoventris haemobaphes* G. M. Allen, 1912, Proc. Biol. Soc. Washington, 25, p. 177.

*Types.*—*Sciurus castaneiventris michianus*, BM No. 8.11.14.13, old female, from Mee Chee, Yunnan, collected January 5, 1903, by

F. W. Styan; *haemobaphes*, MCZ No. 13693, adult male, from Chihping, southeast Yunnan, collected February 26, 1911 by Kobayashi.

*Material examined*, from Yunnan, China.—“Ssu Shan Chang,” 9000 feet, *Likiang* (AMNH), three; Yunnanfu, 6400 feet (AMNH), two; 15 miles south of Kunming [= Yunnanfu] (USNM), one, (MNHN), one; Yunnanyi, 6500 feet (AMNH), one, (CNHM), one; Hangai, 5900 feet, 40 miles east of Talifu (AMNH), one; Chao Chu, 6700 feet, south end of Lake Talifu (AMNH), one; Shan Kuang, 6000 feet, Lake Talifu (AMNH), two, (CNHM), three, (MCZ), one; Mekong-Salween divide at 28° 20' N. latitude, 7000 feet (BM), one; Chepei, Fumin (AMNH), one; Kao Chiao, Yunnanfu (AMNH), six, (MCZ), one; Lungkai, Makaihsien (AMNH), six; Lungkai, Wutinghsien (AMNH), one; “Kun Yang” (AMNH), one; “Nda Mu Cho” (USNM), one; Makaihsien (MCZ), one; Likiang, 9000 feet (MCZ), three, (USNM), six, (CNHM), four, (BM), one; Chihping [Shihping] (MCZ), four; “Hofuping Mountains,” Mekong Valley (USNM), three; Chühsung, 160 miles east of Yunnanfu (CNHM), one; Nui Kai, 7200 feet, 30 miles north of Talifu (CNHM), one; Lo Tu Kow [Lukou] (BM), one; six miles north of Luchang (BM), two.

This subspecies seems to be bounded on the northeast by the Yangtze, but allocation of the Yung-peiting specimen to *gloveri* is made on this assumption in absence of adequate color notes on the specimen. The southwestern boundary of the range of *michianus* is probably the Mekong River. To the south in southern Yunnan *michianus* must surely intergrade broadly with *Callosciurus flavimanus hendeei*.

*Diagnosis*.—Subspecies *michianus* generally differs from *gloveri* to the north by possessing: (1) an agouti throat and a wedge from it extending posteriorly as an incipient midventral agouti stripe; (2) an incipient blackening of the pelage on the posterior two-thirds of the mid-dorsum; (3) a short, incipient, subterminal, black tip to the tail; and (4) digits which are often notably blacker agouti than that of the animal's own gray dorsal pelage. Subspecies *michianus* differs from *castaneoventris* in characters (2) and (4) above, and in lacking a reddish infusion in the agouti dorsal pelage. From *hendeei*, *michianus* differs by characters (1) and (2) above, and the feet of *hendeei* are substantially blacker, and the black tail tip of *hendeei* is substantially blacker and longer, than that of *michianus*. Across the Mekong River from *C. flavimanus michianus* is a subspecies, *C. flavimauns gordonii*, from which *michianus* differs only by being paler and larger.

**Callosciurus flavimanus zimmeensis** (Robinson and Wroughton)

*Callosciurus atrodorsalis zimmeensis* Robinson and Wroughton, 1916, Jour. Fed. Malay States Mus., 7, p. 91.

*Callosciurus ferrugineus primus* Allen and Coolidge, 1940, Bull. Mus. Comp. Zool., 87, p. 157.

*Types*.—*zimmeensis*, BM No. 9.10.11.20, an adult female taken at Chiangmai, 2100 feet, northern Siam on April 12, 1908, by T. H. Lyle; *primus*, MCZ No. 35352, old female from Mae Wan River, 1500 feet, near Mount Souket, north Thailand.

*Material examined*, from Yunnan, China.—Mucheng, 7000 feet (AMNH), four, (CNHM), two, (MCZ), one; Hsiaomengtung, 6000 feet (AMNH), one; Tashutangh, 6000 feet (AMNH), one; Chenkang, 3000 feet (AMNH), two; Chaunglung, Salween ferry, 2000 feet (AMNH), four, (CNHM), three, (MCZ), one; and Nam Ting River at Burma border (AMNH), four, (CNHM), two, (MCZ), two; Mengting, 1700 feet (AMNH), one.

*Material examined*, from Burma.—Malipa (AMNH), one; Ban Sob Pa, Salween River (USNM), two.

*Material examined*, from Thailand.—Doi Soutep (AMNH), three, (BM), seven, (USNM), one; Mt. Chieng Dao (AMNH), one, (USNM), three, (ANSP), three; Pa Kwe, Chiangmai (AMNH), two; Mt. Doi Pui, Chiangmai (AMNH), two; Mong Hawt, Chiangmai (AMNH), two; Ban Kang, base of Doi Angka (USNM), two; Chomtung (USNM), one; Mekhan (USNM), one; Waterfall Mekang (USNM), one; Mae Hong Song (BM), two, (USNM), one; Doi Hua Mot (USNM), one; Doi Angka (MCZ), 13, (CNHM), one; Chieng Mai (ANSP), two, (BM), four; Mee Tan [Ban Mae Tan Nua] (BM), one; Ban Meh Na (NR), two; Doi Par Sakeng (NR), three; Muang Pai, 600 meters (BM), one; "Muang Sang," 425 meters, north of Chiangmai (BM), one; Me Ping River at 18° 00' N., 235 meters (BM), one; "Me Ping River" (BM), four.

This subspecies occupies the waveringly wedge-shaped area between the Salween River and the Mekong River from about 18° north latitude to about 25°, and possibly to 26° or beyond. The type locality is rather close to the area of intergradation with *atro-dorsalis* on the south.

*Diagnosis*.—Subspecies *zimmeensis* differs from *michianus* on the east by being smaller and darker, from *gordoni* on the west by possession of the incipient black posterior middorsum and less nicety of the midsagittal division of the red venter, from *shanicus* by possessing a red, divided venter and five dark bands on the tail hairs, from



*hendeei* by having at least incipient bisection of the ventral red pelage and by having the tail colored like the dorsum or with only a thin buffy tipping (in some southern material), and from *atrodorsalis* and *thai* by having the posterior two-thirds of the middorsum only incipiently black (i.e., without an area of pure black).

*Discussion.*—Note in Figure 13 that *zimmeensis* material is widely divided into two lots. The difference between the northern (Temperate Zone) material of *zimmeensis* and its neighbor across the Mekong is rather slight when compared with characters differentiating other subspecies of this revision of *Callosciurus flavimanus*. If this Temperate Zone sample of *zimmeensis* had shown greater differences from material from Thailand (300 miles into the tropics) we should have included the northern lot in *michianus* rather than naming it as a new subspecies.

For discussion of the named form *primus* see the account of *C. finlaysoni menamicus*.

It is interesting that about the Tropic of Cancer where the populations of species *flavimanus* have been sampled on both sides of the Salween and Mekong rivers which have run closely parallel to one another for about 400 miles, the samples from either side of the Salween are much more highly differentiated from each other than those from either side of the Mekong. See Table 7.

TABLE 7. Subspecies of *C. flavimanus* separated by Salween River and Mekong Rivers 300 kilometers north and 300 south of the Tropic of Cancer.

E. of Salween	W. of Salween, E. of Mekong	W. of Mekong
<i>quingestriatus</i>	<i>zimmeensis</i>	<i>michianus</i>
<i>gordoni</i>	<i>zimmeensis</i>	<i>michianus</i>
<i>thai</i>	<i>zimmeensis</i>	<i>hendeei</i>

### ***Callosciurus flavimanus thai* (Kloss)**

*Sciurus atrodorsalis thai* Kloss, 1917, Jour. Nat. Hist. Soc. Siam, 2, p. 285.

*Type.*—Field No. 2474/CBK (not seen), from Raheng, central Siam, collected July 1916 by C. Boden Kloss.

*Material examined*, from Thailand.—Mewong River, 1000 feet, 40 miles east of Um Pang (AMNH), two; Mewong River, 800 feet, 53 miles east of Um Pang (AMNH), two, (BM), four; 20 miles west of Kempenpet (AMNH), one, (BM), one; "Siam" (AMNH), one;



Muang Kan Bouri [Kanchanaburi] (USNM), three; Ban Pong (USNM), one; Hue Yah Pla, 2500 feet (USNM), two; Me Taqua, 800 feet (USNM), five, (CNHM), one; Wang Kien (USNM), one; Sai Yoke (BM), one; "Dooweeblo," 1500 feet, *Mae Klong* (BM), one; Mae Taw Forest, 900 feet, Raheng (BM), five; Lai Yoke [Ban Sai Yoke] (BM), one; 10 miles west of Raheng, 600 feet (BM), one; Raheng, 115 meters (BM), one; 28 miles east of Um Pang, 2000 feet (BM), two; Doi Mei Lai [Doi Mae Lai] (USNM), one; Doi Mae Kong Kha (USNM), two; Banphotphisai, Nakon Sawan Prov. (USNM), four; Slokbai [Ban Salok Bat], Kano, Kamphaeng Phet (USNM), one; "Tumphol," *Kha Nu*, Kamphaeng Phet (USNM), six; Ban Hua Thanon, Klong Klung, Kamphaeng Phet (USNM), six.

*Material examined*, from Burma.—Lampha, Tenasserim (AMNH), one, (BM), three.

The *zimmeensis* from northern Thailand show some intergradation with the subspecies *thai* to the west and southwest, in occasional occurrence of some pure black pelage on the posterior two-thirds of the middorsum, and in the general occurrence of long light tips on the tail hairs which give to the posterior half of the tail an overlay of straw color (Pale Ochraceous Buff to Light Ochraceous Buff, XV).

*Diagnosis*.—The subspecies *thai* is distinguished from *zimmeensis*, however, by having the following characteristics; (1) regular occurrence of the solid black band of pelage 20–30 mm. wide along the posterior two-thirds of the mid-dorsum; (2) the rostrum, and occasionally the crown, is colored rusty (ranging from only Buckthorn Brown to Hazel); whereas in *zimmeensis* the rostrum and crown are always a cool gray.

*Callosciurus flavimanus thai* is distinguished from *atrodorsalis* by: (3) having its feet a blacker agouti than the legs; (4) having its hind-quarters not notably redder than its forequarters; (5) having long straw-colored tips to the tail hairs (Light Buff to Light Ochraceous Buff) instead of reddish (Ochraceous Buff to Cinnamon Rufous).

*Habits*.—*Callosciurus flavimanus thai* appears to occupy a rain shadow zone in Thailand and is probably found where the forest is primarily deciduous; whereas the following subspecies, *atrodorsalis*, apparently occurs where the forest is primarily broad-leaved ever-green rain forest.

### ***Callosciurus flavimanus atrodorsalis* (Gray)**

*Sciurus atrodorsalis* Gray, 1842, Ann. Mag. Nat. Hist. (ser. 1), 10, p. 263.

*Cotypes*.—BM Nos. 41.1818 and 41.1819, both adult males received from the East India Company, "from Bhotan," corrected by Ryley (1914, p. 663) to Moulmein.

*Material examined*, all from Burma.—Taok Plateau, 3050 feet (AMNH), eight, (BM) four; Zami R., 100 mi. S. of Moulmein (BM), one; Kokareet [Kawkareik], Tenasserim (USNM), one, (CNHM), one, (BM), three; Mt. Nwalabo, Tavoy District (BM), two; Doonsa (BM) one; Thaungyin Valley (BM), one; "Lathorgu," *Myawadi* (BM), one; Ban Sob Pa, Salween R. (USNM), two; Myawadi (BM), two; Sookli [Sukli], Myawaddy Rd. (BM), one; Maitho, Thaungyin River, Tenasserim (BM), one; Haungtharaw River (BM), one; "Shan Mepa," *Amherst* (BM), three.

*Pelage color*.—One striking character that shows the relationship between the subspecies *atrodorsalis* and *thai* is, of course, the broad (20–30 mm.) band of pure black pelage on the posterior two-thirds of the mid-dorsum. Many subspecies of *flavimanus* have an incipient manifestation of the black band but only *atrodorsalis* and *thai* have it pure black.

The agouti dorsal pelage varies considerably in color individually among specimens from the rainforest of the Tenasserim region, depending upon the amount of infusion with red. The rostrum in the *atrodorsalis* at the American Museum of Natural History is redder (Hazel to Kaiser Brown, XIV) than the dorsal pelage on the same individual. The anterior dorsal pelage in the Tenasserim AMNH series ranges from about Hazel in the reddest to about light Brownish Olive (XXX) in the grayest. The posterior half of the dorsal pelage (exclusive of the black stripe) is redder on each individual than the anterior half, the range in the same series being about Russet (XV) to Saccardo's Umber (XXIX). The tail is just about as reddish as the hindquarters on each individual. The feet, unusual in this species, are no blacker agouti than the legs.

*Discussion*.—This subspecies occupies the very heavy rainfall area of Tenasserim and is much redder than the adjacent subspecies *thai* which occupies the contiguous rainshadow area in Thailand.

Anderson (1879, p. 233) placed a great deal of stress on the occurrence of two color phases in *atrodorsalis*, the more common one with a broad black band on the back, the other without. He found that the difference between the two was not sexual dimorphism and that neither color phase exclusively represents the stage of maturity. Whether it is seasonal, his material was not adequate to reveal, and

we have examined too few of the ones lacking black patches to say. For the geographic range that Anderson attributed to *atrodorsalis* (Moulmein to Malacca), the difference has now been shown to be geographic, indeed, but he was also concerned with the local variation in the Moulmein area and to the east of Moulmein. Here he declared the evidence was non-geographic but he did not state the evidence in adequate detail for one confidently to agree. Anderson (1879, p. 235) also states that "*atrodorsalis* is very common in Martaban. . . ." We have seen no specimens from there, and since neither *caniceps* nor *phayrei* are known to have crossed the Salween River, we have presumed (in absence of any substantial evidence) that *atrodorsalis* does not cross it either. If this is the case, it may well be that the squirrel species Anderson mentions occurring in Martaban is in fact *hyperythrus*. He considered the type of *hyperythrus* to represent the phase of *atrodorsalis* without the black band on the back. We observed nothing about the type specimen of *hyperythrus* which mitigates against this concept (see description above), but it seems quite possible that squirrels taken just across the river from Moulmein at Martaban might in those days have been quite freely labeled "Moulmein," and that such material may in part constitute the phase of *atrodorsalis* without the black back which Anderson (1879, p. 233) describes from the Moulmein region.

This problem will, of course, not be solved by disposition here of the name *hyperythrus*. What is needed is a series of specimens from Martaban and any points north of there (and west of the Salween) for comparison with the type of *hyperythrus* and with new material of the scarcer color phase of *atrodorsalis* (if any) from the Moulmein area and eastward from there toward Kawkereik and Myawadi.

### ***Callosciurus flavimanus siamensis* (Gray)**

*Sciurus siamensis* Gray, 1860, Ann. Mag. Nat. Hist. (ser. 3), 5, p. 500.

*Sciurus atrodorsalis tachin* Kloss, 1916, Jour. Nat. Hist. Soc. Siam, 2, p. 178.

*Types*.—*Sciurus siamensis*, BM No. 59.7.8.1, young adult with dp<sup>4</sup> present, from Siam, collected by M. Mouhot; *tachin*, USNM No. 221566, a young adult female from Pak Bu, Tachin, Siam, taken on October 23, 1916, by C. Boden Kloss.

*Material examined*, all from Thailand.—Bangkok (AMNH), three, (CNHM), six, (MCZ), 12, (UMMZ), 10, (USNM), 22; Pak Jong (AMNH), one; "Doi Souket," 6500 feet (MCZ), one; Paknampoh (MCZ), one; Tachin (USNM), six; Rajaburi (USNM), three; Potaram, near Ratburi (USNM), one; Ban Pong, near Rajaburi (USNM), one.



*Material examined*, of intergrades with *C. f. thai*, all from Thailand.—Paknampo, Nakorn Sawan (USNM), four; Moung Wat Sy, Nakorn Sawan (USNM), one; Kowkat, Paknampo, Nakorn Sawan (USNM), four; Kowkob, Paknampo, Nakorn Sawan (USNM), one.

*Material examined*, of intergrades with *C. f. pranis*.—Tra Khanun, Kanachanaburi, Thailand (USNM), three; Hinlaem, Tra Khanun, Kanachanaburi, Thailand (USNM), one.

The type locality of *tachin* seems to be the southwest edge of the geographic range of this subspecies, and material from there shows intergradation with *pranis*. Consequently, material from Tachin, Ratburi (= Rajaburi), Potaram, and Ban Pong are to be expected to show evidences of such intergradation.

*Diagnosis*.—This subspecies is best known from the large series from Bangkok in several museums. *C. f. siamensis* is distinguished from *C. f. thai* on its west by having: (1) a maximum of four blackish bands on the tail hairs instead of five; (2) the tail increasingly red toward the tip instead of ivory or yellowish white; (3) the feet no blacker agouti than the legs; (4) the venter duller red, generally about Tawny or Hazel (although we recorded extreme ones as brilliant as Burnt Sienna), whereas ventral pelage in six out of seven *thai* is Mahogany Red and the other Burnt Sienna; (5) smaller size; (6) no indication of a broad black longitudinal stripe on the posterior two-thirds of its mid-dorsum.

From *C. f. zimmeensis* to the north, *siamensis* is also distinguished by above characters numbers 1, 2, 5, and 6.

From *C. f. pranis* to the south, *siamensis* is distinguished by above characters numbers 2, 3, and 6.

### **Callosciurus flavimanus pranis (Kloss)**

*Sciurus erythraeus pranis*, Kloss 1916, Jour. Nat. Hist. Soc. Siam, 2, p. 178.

*Type*.—USNM No. 221568, an old male from Koh Lak [Prachuap Kiri Khan], southwest Siam [Thailand], taken November 9, 1916, by C. Boden Kloss.

*Material examined*, all from Thailand.—Koh Lak [Prachuap Kiri Khan] southwestern Siam (USNM), six, (NR), four, (BM), two; Hue Sai (NR), one; Sungei Balik (BM), one; Bok Pyin (USNM), two; Khao Luang, 3400 feet (ANSP), two; "Khao Nok Wua," 2000 feet (ANSP), one.

*Pelage color*.—The dorsal pelage is agouti and as a whole appears to be about Olive Brown and indistinguishable from that of *tachin*



except that *pranis* regularly has an incipient expression of the black middorsal stripe that demonstrates its relationship to *atrodorsalis*. The reddish ventral pelage is regularly divided longitudinally by a narrow band of agouti pelage. The color of the reddish pelage ranges from Tawny Olive (XXIX) to Tawny. It also shows relationship to *atrodorsalis* and *tachin* in having the pelage of the rostrum hazel, and the ears tinged with the same color.

*Discussion.*—This as yet poorly known subspecies is intermediate in some characteristics between *C. f. atrodorsalis* and *rubeculus*, but the material is difficult to shrug off as series of intergrades, because it seems consistently to possess a lighter, less richly colored venter than either *atrodorsalis* or *rubeculus*.

***Callosciurus flavimanus rubeculus* (Miller) [extraterritorial]**

*Sciurus rubeculus* Miller, 1903, Smithsonian Misc. Coll., 45, p. 22.

*Sciurus erythraeus youngi* Robinson and Kloss, 1914, Ann. Mag. Nat. Hist. (ser. 8), 13, p. 224.

*Types.*—*S. rubeculus*, USNM No. 86777, old male from Khao Soi Dao, 1000 feet, Trong, collected February 21, 1899, by W. L. Abbott; *youngi*, BM No. 21.11.8.11, old female, from Teku Plateau, 5000–6000 feet, Gunong Tahan, north Pahang, collected July 19, 1911, by H. C. Robinson and C. B. Kloss.

*Discussion.*—Here is another subspecies which takes its name from a type specimen obtained in an area of intergradation with an adjacent subspecies. The typical material from Trong shows some trend toward intergradation with the only adjacent subspecies, *pranis*.

Although *C. f. rubeculus* is partially isolated on a long peninsula far removed from most of the range of its species, it displays a most intensive expression of those conservative pelage characters which are so widespread in the species as to be regarded "typical" of the species. (No known pelage or other character has been found which delimits the species *flavimanus*.) These widespread characters are: faintly orange-rimmed ears, agouti feet blacker than the legs and sides, dark red ventral pelage bisected longitudinally by a narrow band of agouti gray pelage, tail hairs with four or five blackish bands.

*Diagnosis.*—This subspecies is here distinguished from the only other conspecific one with which it is in contact, *C. f. pranis*, by: (1) absence of any suggestion of a broad blackish band on the posterior two-thirds of the mid-dorsum; (2) darker, richer ventral pelage; (3) blacker feet; (4) gray rostrum.

Subspecies *rubeculus* is not mapped here.

***Callosciurus flavimanus hendeei* (Osgood)**

*Callosciurus erythraeus hendeei* Osgood, 1932, Field Mus. Publ. Zool., 18, p. 270.

*Type*.—CNHM No. 32290, an adult male taken at Chapa, Tonkin, February 14, 1929, by Russell W. Hendee.

*Material examined*, from Tonkin.—Chapa, 5000 feet (CNHM), six, (MCZ), two, (USNM), one, (BM), 12; Bao Ha, 500 feet (CNHM), one, (BM), six; Muong Mo, 750 feet (CNHM), four, (USNM), one; Muong Boum (CNHM), one; Lieng San [Leng Sang], 1500 meters (CNHM), one; Pakha [Pa Kha] (CNHM), two; Isle de la Table (BM), one; Lao Kay (MCZ), three; Thai Nien, 300 feet (BM), four; Lai Chau (USNM), one, (MNHN), one; Langson, 500 feet (BM), one; Tam-dao (MNHN), one, (BM), four; Bac Kan (BM), four; "Chora," 1000 feet (BM), one; Ha-Giang (MNHN), one; Ngan-son, 3000 feet (MNHN), one; Muong Moun (AMNH), two.

*Material examined*, from Laos.—Lao Fou Tchay, 3400 feet (CNHM), one; Phong Saly, 4400 feet (CNHM), four, (USNM), one; Muong Yo, 2300 feet (CNHM), two; Lo Tiao (MCZ), one; 2 km. east of Nam Khueng (MCZ), one; Houé Sai (MCZ), one.

*Material examined*, from Annam.—Phu Qui, 100 feet (CNHM), two, (MNHN), one, (BM), seven; Than Hoa (CNHM), one; Hoi Xuan (CNHM), one; "Lung-lunh" (CNHM), two, (BM), one; Lung Van, 1000 meters, pr. de Thanhhoa (USNM), one; "Nam Da, near Tatka" (BM), one; Nghia Hung, 100 feet, Phu Qui (BM), seven.

*Material examined*, from China.—"San-ho Hsien," Kweichow (CNHM), one; "Shui-kow-kwan," Lungkow, Kwangsi (CNHM), one.

For discussion of characters and relationships see *castaneoventris* and *flavimanus*.

***Callosciurus flavimanus castaneoventris* (Gray)**

*Sciurus castaneoventris* Gray, 1842, Ann. Mag. Nat. Hist. (ser. 1), 10, p. 263.

*Sciurus erythraeus insularis* J. A. Allen, 1906, Bull. Amer. Mus. Nat. Hist., 22, p. 473.

*Types*.—*Sciurus castaneoventris*, BM No. 72A, young female and 72B adult male, both from "China," evidently the vicinity of Canton and collected between 1812 and 1831, for they were presented by John R. Reeves (who worked there as a tea taster during that time; see Moore and Tate, 1959); *S. e. insularis*, AMNH No. 26609, parous female from "Lei-Mui-Mon," Hainan, taken January 5, 1903 by agents of Alan Owston.

*Material examined*, all from Hainan, China.—“Lei Mui Mon” (AMNH), 14; “Utoeki” (AMNH), one; “Luidon” (AMNH), one; “Hainan” (AMNH), three; Nodda (AMNH), 80, (USNM), two, (CNHM), 14, (BM), one, (MCZ), six; Nam Fong (AMNH), seven, (CNHM), two; Kachek (USNM), one; “Ngau Tchi Lea Mts.” (MCZ), one, (BM), one.

*Discussion*.—No specimens of the species *flavimanus*, other than the cotypes collected by Reeves are known from the vicinity of Canton, but Robinson and Kloss (1918, p. 199) compared the cotypes with material from Hainan and found them to be indistinguishable, thus rendering J. A. Allen's subspecies *insularis* from Hainan a synonym of *castaneoventris*. Without comment these authors thereupon substituted Hainan as type locality for the “China” which was the only type locality provided by Gray in his original description of *castaneoventris*. While that substitution was a considerable improvement in its time, as indicated above, it now seems better to accept the vicinity of Canton as type locality, but only provisionally until further material becomes known from there.

There were two specimens involved in the original description of *castaneoventris*. The first mentioned was a rather darker one (BM No. 72B) the original description of which amounts to, “Very like *S. hippurus*, but only half the size, and the ears are gray.” This implies red ventral pelage like that of *hippurus*, for Gray proceeds to contrast the variant second specimen with it, “Var. rather paler; chin grayish, beneath yellowish red.” The amount of variation implied does not require that the type series came from widely different localities nor that it came from a single locality which is in an area of intergradation between two subspecies (*castaneoventris* and *ningpoensis*). Nevertheless, the location of Canton, from which the type material is presumed to come, in reference to known localities for *ningpoensis* and subsequent *castaneoventris* material does suggest this latter possibility, and the Hungshui River which debouches about Canton and Macao, could quite possibly form a partial, natural barrier between the two subspecies. If this should prove to be the case, the type series does better represent the southern, not the northern subspecies, and no need is anticipated to alter the well-established usage of *castaneoventris* for Hainan material and *ningpoensis* for that from Fukien.

In his diagnosis of the subspecies *hendeei* Osgood (1932, p. 270) stressed no single character which could be depended upon alone to distinguish it from the one on Hainan, but stated all the differences



in subjectively comparative terms. It seems worthwhile to provide quantitative differences here as we find them to exist.

*Pelage color.*—Among the large series of *castaneiventris* from Hainan at the American Museum of Natural History there are only five individuals that have a full-length midventral band of agouti pelage. There are 56 that have agouti throats and an agouti wedge extending onto the breast, and 41 that have neither midventral band nor wedge. This contrasts with the series of thirty skins of *hendeei* at Chicago Natural History Museum in which there were no full-length, ventral, median bands of agouti and only one with an agouti wedge on the breast (No. 32297).

The ventral pelage color of the large AMNH series from Hainan is about Mahogany Red in about 30 specimens. There are one or two skins of adults in good pelage as pale as Mars Orange, and the remainder are about Burnt Sienna (except for one individual from Nodda (AMNH No. 58133) which has such an exceptionally agouti venter that virtually only the insides of the legs have really red pelage. The possibility of such aberrant individuals elsewhere needs to be borne in mind in this species). This is a very high degree of consistency in ventral pelage color compared with *ningpoensis*. In the (smaller) Chicago collection of *hendeei* material, however, the ventral pelage color was found to vary from about Morocco Red to Hays Russet, a range of variation which is even more conservative than the *castaneiventris*.

*C. f. castaneiventris* and *C. f. hendeei* both have five black bands on the tail hairs.

The most constant and obvious color difference between the *hendeei* and *castaneiventris* as represented in the large series at Chicago and New York is the color of the tip of the tail. In the Hainan material there appears to be no variation away from a white-upon-black-tipped tail. Some description is necessary here. The tail hairs of these *C. f. castaneiventris* from Hainan, excepting near the distal end of the tail, have five blackish bands and a minute blackish tip as is widespread in the species. But the light subterminal band is unusually light in this species (about Cartridge Buff) and is progressively longer toward the extremity of the tail, often exceeding a centimeter at the extremity, but rarely two centimeters. The most distal black band becomes progressively longer, also, toward the end of the tail, by spread toward the base of the hair. Thus, at the end of the tail the subterminal whitish band of one centimeter is distal to a sub-subterminal black band of from two to five centi-



meters. (Osgood, incidentally, ignored the minute blackish tips of the hairs and described the whitish bands as terminal.)

The tips of the tails of the *hendeei* series at Chicago Natural History Museum are characteristically and uncomplicatedly black. There are four (three from Chapa and one from Lung-lunh), however, which do have long, light bands superimposed on the extremities of the black hairs, rendering them indistinguishable by this criterion from Hainan material. However, 87 percent is a fairly good distinction of subspecific material (Amadon, 1949) on the basis of a single color character.

*Dimensions*.—Size is something on which we can also provide data: Greatest skull length in 36 adults of *castaneoventr* ranges from 50.2 to 53.5 mm., except for two well outside the curve at 55.0 and 55.9, and 29 (80 percent) are less than 53 mm. long; whereas all 17 skulls of adult *hendeei* are 53 mm. or more in length. Similarly, the hind foot length of the adults of *hendeei* ranges from 54 to 59 mm., but in a sample of 61 adult *castaneoventr* only four range above 53 mm.

### ***Callosciurus flavimanus flavimanus* (Geoffroy St. Hilaire)**

*Sciurus flavimanus* Geoffroy St. Hilaire, 1831, in Belanger, Voyage Indies Orientales, 1, p. 148.

*Callosciurus flavimanus quantulus* Thomas, 1927, Proc. Zool. Soc. London, 1927, p. 51.

*Callosciurus flavimanus contumax* Thomas, 1927, Proc. Zool. Soc. London, 1927, p. 52.

*Callosciurus flavimanus dactylinus* Thomas, 1927, Proc. Zool. Soc. London, 1927, p. 52.

*Callosciurus flavimanus pirata* Thomas, 1929, Proc. Zool. Soc. London, 1928, p. 836.

*Callosciurus flavimanus bolovens* Osgood, 1932, Field Mus. Nat. Hist., Zool. Ser., 18, p. 276.

*Types*.—*S. flavimanus*, MNHN No. 177, from Tourane, Annam; *quantulus*, BM No. 26.10.4.96, adult male from Xieng Quang Koo, Laos, collected December 19, 1925, by J. Delacour and W. Lowe; *contumax*, BM No. 26.10.4.104, adult female from Kontoum, Annam, collected February 27, 1926, by J. Delacour and W. Lowe; *dactylinus*, BM No. 26.10.4.101, old female from Dak-to, Annam, collected March 16, 1926, by J. Delacour and W. Lowe; *pirata*, BM No. 28.7.1.79, adult female from Nape, 2500 feet, Laos, collected February 11, 1928 by J. Delacour and W. Lowe; *bolovens*, CNHM No. 37874, old female from Paksong, Indochina, collected January 24, 1932 by J. Delacour.

*Material examined*, from Annam.—Col de Nuages, 400 meters (MNHN), eight, (BM), 12; Thua Luu, 150 feet (BM), two; Dak To (BM), two, (MNHN), two; Kao Hao, Quangtri Province (BM), one; Kontoum [Kontum] (BM), two, (MNHN), two; Hué (BM), one; Cua-Ting, Quangtri (BM), one; Quangtri (BM), one, (MNHN), one, (CNHM), six, (USNM), one; Dong Hoi (MNHN), one; Quangtri River (MNHN), one.

*Material examined*, from Laos.—Thateng (CNHM), 15, (BM) one, (USNM), one; Napé, 2500 to 3000 feet (BM), five; Xien Kuang Koo [Xien Khouang] (BM), three, (MCZ), two; Pasa (AMNH), one; Don Qua (AMNH), one; Plateau Bolovens (AMNH), four; Phu Kobo (MCZ), two; Bantion [Ban Tayun] (CNHM) one; "Pakhout" (CNHM), one; Pak Song (CNHM), one; Nong Kai [presumed to mean in Laos across the river from Nong Kai, Thailand] (USNM), one.

*Discussion*.—The two AMNH specimens from Pasa and Don Qua, villages on the Nam Khan (river) between Luang Prabang and M. You, exhibit a condition of intermediacy between *C. f. hendeei* and *C. f. flavimanus*. There is no geographic barrier between these localities and those of the *hendeei*. There is no difference from *hendeei* in the appearance or size of the Pasa and Don Qua skulls, and body measurements of these and *hendeei* taken by the same collector (T. Donald Carter) offer no hint of a size difference. The rostrum is colored like the dorsum as in *hendeei* rather than orange-yellow as in *flavimanus*. The feet are agouti like the back, a stage midway between the blackened agouti of *hendeei* and the orange-yellow of *flavimanus*. However, the Pasa specimen possesses pronounced blackish agouti on its toes showing more influence of the *hendeei* character; whereas the Don Qua one lacks the blackish agouti entirely but has a faint infusion of reddish-orange around the ankles (absent in the Pasa specimen) showing more the influence of *flavimanus*. In both of these Nam Khan (river) specimens the tail is colored like the back but brighter buff approaching the condition of *flavimanus*, not black-tipped like *hendeei*.

The Museum of Comparative Zoology material from Xien Khouang and Phu Kobo seems to be quite good *flavimanus* with no indication of intergradation; but five of the six Chicago Natural History Museum specimens from Quangtri have abrupt solid black tail tips indicating some penetration of *hendeei* characteristics even to that locality. Both of the Nam Khan specimens have four prominent blackish bands on the tail hairs. This is a reduction of one from the

number characteristic of *hendeei* and one or two more than is common in *flavimanus* farther south.

The magnitude of difference between diagnostic characteristics of *flavimanus* and *hendeei* does greatly exceed that between *hendeei* and any of the Chinese subspecies. The evidence of intergradation described above compels us, however, at this state of our knowledge, to regard subspecies *flavimanus* and *hendeei* as conspecific. It is also quite evident to us that *flavimanus* material is much more variable individually than is that of *hendeei*, but these conditions in no way justify admission as good subspecies any of the many other names that have been applied in this case.

*Pelage color*.—The characteristics accepted for *flavimanus* are orange-yellow rostrum and fore feet, and reddish-orange hind feet. The tail may be colored like the dorsum or buffier or approaching the color of the venter. The venter varies among individuals from Mars Orange to Burnt Sienna. This color extends from wrist to ankle and covers the venter except for the agouti scrotum and chin. An occasional individual shows feeble anterior indications of a mid-ventral agouti stripe. Faint indications of a broad, black midstripe on the posterior two-thirds of the dorsum is characteristic.

### ***Callosciurus flavimanus griseimanus* (Milne-Edwards)**

*Sciurus griseimanus* Milne-Edwards, 1867, Rev. Zool. (ser. 2), 19, p. 195.

*Macroxus leucopus* Gray, 1867, Ann. Mag. Nat. Hist. (ser. 3), 20, p. 282.

*Sciurus leucopus fumigatus* Bonhote, 1907, Abstr. Proc. Zool. Soc. London, no. 38, p. 2.

*Sciurus vassali* Bonhote, 1907, Proc. Zool. Soc. London, 1907, p. 9 (footnote, a new name for *fumigatus* Bonhote, 1907, not of Gray, 1867).

*Callosciurus ferrugineus phanrangis*, Robinson and Kloss, 1922, Ann. Mag. Nat. Hist. (ser. 9), 9, p. 91.

*Types*.—*Sciurus griseimanus*, MNHN No. 1864-679(167), adult male from Saigon, collected by R. Germain; *leucopus*, BM No. 60.8.28.13, adult male from Cambodia; *vassali*, BM No. 6.11.6.25, male, from Bali, near Nhatrang, Annam; *phanrangis*, BM No. 26.-11.17.5, adult female from Tour Cham near Phanrang, south Annam, collected May 23, 1918, by C. B. Kloss.

*Material examined*, from Annam.—Djiring, 3000 feet (BM), 11, (MNHN), four; Da Ban (BM), one; Nhatrang (BM), 12; Phanrang (BM), one; Lang Bian Peaks (MCZ), one; Pie de Langbian (MCZ), one; forest of Krongba [Krong Ba] (USNM), one.



*Material examined*, from Cochin China.—Tayninh (BM), four, (MNHN), six; An Binh (BM), three; Trang Bom (BM), two; An Blu (MNHN), one; "Arboretum de" *Trang Bom*, Province de Bien Hoa (USNM), three; Bien Hoa (USNM), five; (MNHN), one; "Montaojur de Nrii," *Chua Chan* (USNM), one; "Prang," (USNM), one; Baria (CNHM), two; Ninh Hoa (CNHM), two; Phan Rang (CNHM), two; "Gougah" (CNHM), two; Ban Me Thuot (CNHM), two; "Eaktur" (CNHM), one.

*Diagnosis*.—The distinguishing characteristics of *griseimanus* are: (1) very light dorsal pelage, some Mouse Gray, some Drab; (2) seemingly white feet, about Cream Buff in some, Cartridge Buff in others; (3) tails not tipped with a contrasting color, but unusually disposed to show transverse annulations, numbering about ten; (4) number of blackish bands on tail hairs at least four, often five.

There is, in *griseimanus*, as in *flavimanus*, a great deal of variation that is individual or microgeographic or both.

*Pelage color*.—The ventral pelage color in eleven specimens at the CNHM varies from Sanford's Brown in two, through Ochraceous Buff in two, Cinnamon Buff in five, to something lighter still in two immatures from Phan Rang. Bisection of the ventral pelage by an agouti stripe is incipient in four of these eleven.

*Discussion*.—A specimen (USNM 256749) indistinguishable from *hendeei* was, according to the label, taken by Poilane on Nua Chua Chan, a small mountain close to Bien-hoa; Cochin China, deep in the range of subspecies *griseimanus*, from which *hendeei* differs greatly. A companion specimen of *hendeei* was taken by Poilane (USNM 256748) at Lung Van, Than Hoa Province, Annam, well within the proper range of *hendeei*. It seems rather more likely that the first specimen somehow became erroneously labeled than that a squirrel which is indistinguishable from *hendeei* could in fact have been taken on Nua Chua Chan (see map of species *flavimanus*, figure 13).

The color difference between subspecies *griseimanus* and *flavimanus* is just as striking as that between subspecies *flavimanus* and *hendeei*, but it is color intensity which differs more than pattern, and in view of the color patterns common to these first two forms and absence of any geographical barrier between them, it would seem unrealistic to us even in the absence of noticed intergradation, to regard *griseimanus* and *flavimanus* as more distinct than subspecies.



**Callosciurus flavimanus gloveri** (Thomas)

*Callosciurus castaneiventris gloveri* Thomas, 1921, Jour. Bombay Nat. Hist. Soc., 27, p. 502.

*Type*.—*Callosciurus castaneiventris gloveri*, BM No. 13.9.13.3, young female, from Nagchuka, 10,000 feet, west Szechwan, collected August 14, 1908, by W. R. Zappey.

*Material examined*, from Szechwan, China.—West of Fulin, 5000 feet (USNM), one; Ningyuanfu, 6200 feet (USNM), one; "Tanken" (USNM), one; 40 miles E. of Hokow (ANSP), one; Hokow (= Nagchuka) (ANSP), one topotype, Nagchuka, 10,000 feet (BM), one topotype; "Toloko," south of Muli (MCZ), one, (ANSP), one; Nachukar [Nagchuka] (MCZ), three topotypes, (USNM), one; Rama La Pass, 13,000 feet (MCZ), three; Mili [same as Muli] (CNHM), three, (USNM), three; Baurong (CNHM), four, (ANSP), one.

*Material examined*, from Yunnan, China.—Yungning (CNHM), two; Yung-pei-ting, "N. 27° 10', E. 100° 50'" [Yungpeh] (BM), one.

*Material examined*, from Tibet.—"U-long-si Gorge," 14,000 feet (USNM), two.

*Pelage color*.—Color notes from material examined in the Museum of Comparative Zoology and Chicago Natural History Museum that includes three topotypes: The ventral pelage varies from Hay's Russet (XIV) through Vinaceous-Rufous to Ferruginous from individual to individual, but is consistent on any one specimen from throat to tail and wrists to ankles, and is not in any instance divided by a mid-sagittal agouti band, even incipiently. Dorsal pelage an agouti of about Mouse Gray (LI) at the more northern localities of Nagchuka and Rama La Pass, Grayish Olive (XLVI) at Baurong, and Dark Olive Buff (XL) at the more southern localities of Mili and Yungning. Inner side of pinna is Apricot Buff (XIV) in the more northern material and Cinnamon Rufous to Vinaceous Rufous in the southern, but at Baurong there is just a hint of warm color in the gray. The pelage of the feet is colored like that of the dorsum. The tail is colored like the dorsum for its full length, and the tail hairs (at Yungning, Mili, and Baurong, at least) have six dark bands, and tips of Ochraceous Buff (at least in the north).

*Discussion*.—This rather variable subspecies shows relationship to *intermedius* to the west and *bonhotei* to the east in having undivided ventral pelage and uniformity in color of tail. It differs from both of them in having reddish ears and unblackened feet. Its dorsal pelage is also paler than that of *intermedius* and lacks the reddish infusion.

**Callosciurus flavimanus bonhotei** (Robinson and Wroughton)

*Sciurus castaneiventris bonhotei* Robinson and Wroughton, 1911, Jour. Federated Malay States Mus., 4, p. 234.

*Type*.—BM No. 8.8.11.25, an adult female taken at Chin Chien San, Szechwan, China, by F. W. Styan.

*Material examined*, all from Szechwan, China.—Lian-feng-Kiang, Omei Shan (CNHM), one; Yaichowfu [Yachowfu], Omei Shan (CNHM), two, (USNM), one, (ANSP), three; "Ho Ni Pa" (CNHM), nine; Fi Shan Kwan (CNHM), eight; Lu Chang Pu (CNHM), two; Yung Cha Shan (CNHM), one; Chung Chiao [Chiang] Miao (CNHM), one; Hsiao Yang Chi (CNHM), one; Fu Fu Su (CNHM), three; Ninguanfu (USNM), one, (BM), one; "Tai Tsin Tang" (USNM), one; "Wan Nien Si" (USNM), one; "Lu Din" (USNM), one; Kia-ting (USNM), two; Mt. Omei (USNM), four; Suifu (USNM), two; "Shin Kai Si," Mt. Omei (USNM), five; Wan hsien (MCZ), one; "Chen Yen Say" (BM), one; "Yusu-Ching-Hsien" (BM), one; "Szechwan" (BM), two.

There is a specimen referable to *gloveri* as well as one referable to *bonhotei*, both taken at Ningyuanfu and both showing some indications of intergradation. As the map shows, there is one other point at which individuals bearing the characteristics of these two subspecies were taken very close together.

*Pelage color*.—The agouti dorsal pelage of the *bonhotei* material at Chicago Natural History Museum is generally about Dresden Brown (XV) with the reddest variant being Sudan Brown (III). The tail hairs have six dark bands and sometimes seven. The ventral pelage is Burnt Sienna and is not divided in any of this series. Very little warm color can be found on the ears.

*Discussion*.—Although somewhat variable, the material reported above appears to represent a distinct enough geographic subspecies which is richer in ventral pelage and darker in dorsal pelage than the adjacent *gloveri*, and also differs by having its feet slightly blackened and the reddish orange color almost absent from its ears. Resemblance to *hendeei* of eight specimens from Fi Shan Kwan and two from Lu Chang Pu in characters of dorsal pelage is noted. However, these are the most northwestern and most southeastern of the collecting localities found. In the Lu Chang Pu two the tail has a long, black subterminal mark with the tip itself buffy or whitish, which is also like the northern *hendeei* known to us. In the other 19 examples of *bonhotei* in the Chicago Natural History Museum series,

however, difference from *hendeei* in dorsal pelage characters is fairly substantial.

It is interesting to note that the northern limit suggested by the collecting localities mapped here may be close to correct. The Sage West China expedition of the American Museum of Natural History collected west and north out of Wenchwan for a total of about two months without taking squirrels of this species. They obtained series of other squirrels (*Dremomys*, *Sciurotamias*, and *Tamiops*) and good stands of coniferous forest and bamboo forest in the vicinity of their camps are evident in photographs shown to us by T. Donald Carter of that expedition. Most of their collecting was above 6000 feet.

### ***Callosciurus flavimanus styani* (Thomas)**

*Sciurus styani* Thomas, 1894, Ann. Mag. Nat. Hist. (ser. 6), 13, p. 363.

*Macroxus griseopectus* Milne-Edwards, 1874, Recherches pour servir a l'Histoire Naturelle des Mammifères . . . p. 305 (not *griseopectus* Blyth, 1847).

*Herpestes leucurus* Hilzheimer, 1905, Zool. Anz., 29, p. 299.

*Herpestes albifer* Hilzheimer, 1906, Abh. Ber. Mus. Nat. Heimatk. Magdeburg, 1, p. 177 (substitute for *H. leucurus*, preoccupied).

*Callosciurus caniceps canigenus* Howell, 1927, Jour. Washington Acad. Sci., 17, p. 81.

*Callosciurus erythraeus woodi* Harris, 1931, Occas. Papers Mus. Zool., Univ. Michigan, no. 228, p. 1.

*Types*, all from China.—*S. styani*, BM No. 86.10.28.5, young female "from between Shanghai and Hangchow [about 100 miles], probably Kahing . . ." [Kashing]; *griseopectus*, collected by A. David in Chekiang; *leucurus*, "2 Felle."; *albifer*, "2 Felle. In Hankau gefaut. 1905"; *C. canigenus*, USNM No. 241509 an adult male taken at Hayenhshien, Hangchow Bay, Chekiang, December 10, 1925, by Arthur de C. Sowerby; *woodi*, UMMZ No. 55827, adult male, taken at Lungtan in the Purple Mountains 25 miles east of Nanking, Kiangsu, south side of Yangtse River, December 14, 1923, by Norman A. Wood.

*Material examined*, all from China.—Tehan (UMMZ), one; Wan Mts., 100 mi. S.W. of Nanking, Anhwei (UMMZ), five, (MCZ), two; Purple Mts., Lungtan, 25 mi. E. of Nanking, Kiangsu (UMMZ), three; Tunglu, Chekiang (AMNH), one, (MCZ), nine; Mokanshan, Chekiang (ANSP), three; Hai Yen Hsien, Hangchow Bay, Chekiang (USNM), two; Kangpu, near Hangchow, Chekiang (USNM), one; Nimrod Sound, coast of Chekiang (ZMHU), one; "Anhwei" (NR), 17; "Chien San," Anhwei (BM), three; Lushan Hills, Kiukiang,



Kiangsi (BM), one; "Hung Fa Chao," *Shanghai* (UMMZ), one; "Kin King," Chekiang (USNM), one.

We are in agreement with G. M. Allen (1940, p. 633) on the above synonymy, which he has fairly and adequately discussed (pp. 634, 635).

*Pelage color*.—The series from the Wan Mountains are dorsally an agouti of Light Brownish Olive (XXX) in most, but one is Buckthorn Brown (XV). There are five blackish bands on the individual tail hairs. There is an abrupt, short tip of black hairs present on the tail, but this is obscured to some extent by whitish or buffy tips even on the otherwise entirely black hairs. No orange is seen on the ears nor black on the feet. The ventral pelage is Light Ochraceous Buff to Pale Ochraceous Buff. Chin or chin and throat are agouti like the dorsum. There are two from the Purple Mountains with ventral pelage that is Pale Pinkish Buff to almost White, and their dorsal pelage is agouti of about Dark Olive Buff (XL) which is very slightly lighter than the lightest of the series from the Wan Mountains. The other Purple Mountains specimen, however, has blackish feet, dorsal pelage agouti of about Dresden Brown, and ventral pelage of Morocco Red. All three from the Purple Mountains have chin or chin and throat agouti and ears concolorous with dorsum.

*Discussion*.—Thomas (1894) distinguished *styani* from "*castaneo-ventris*" to the south by the ventral pelage being a "peculiar reddish cream-colour ('pinkish-buff' of Ridgway) instead of the rich rufous ('orange-rufous') of the older known form." A good deal more material has since become available, and although some variation toward *ningpoensis* characteristics is seen in *styani*, the difference is still as Thomas said "extremely striking." When the material is compared in series, a general difference is also evident in the color of the dorsal pelage, but there is some overlap among individuals. As Thomas said also, in other pelage characters the two subspecies seem to be quite alike.

Harris (1931) proposed the name *woodi* for material from east of Nanking in the Purple Mountains which has lighter pelage in both dorsum and venter than previously found in *styani*. However, some years later he obtained another specimen (UMMZ No. 87081) from the same vicinity with dorsal pelage about Dresden Brown (XV) and ventral pelage that is about Morocco Red (I). This must be regarded as a most exceptional specimen for *styani*, and it certainly invalidates *woodi* as a subspecies.



Since the subspecies *styani* is known from quite close to the south of the Yangtze Kiang in several places but as yet from no localities north of that great river, it seems possible that the lower course of the Yangtze in eastern China has been a barrier to northward spread of *C. flavimanus*.

### **Callosciurus flavimanus ningpoensis** (Bonhote)

*Sciurus castaneoventris ningpoensis* Bonhote, 1901, Ann. Mag. Nat. Hist. (ser. 7), 7, p. 163.

*Sciurus tsingtanensis* Hilzheimer, 1905, Zool. Anz., 29, p. 298 ("corrected" to *tsingtauensis*, 1906, Abhandl. Berichte Mus. Natur. Heimatk. Magdeburg, 1, p. 172).

*Types*.—*Sciurus c. ningpoensis*, BM No. 86.10.28.3, old individual from hills 30 miles from Ningpo, collected March, 1884, by F. W. Styan; *tsingtanensis*, ZMHU (Kreyenberg) No. 238, a male collected August 16, 1902, by Kreyenberg (at Nimrod Sound, coast of Chekiang, according to G. M. Allen, 1940, p. 632) just south of Shanghai (Tsingtao is 400 miles farther north).

*Material examined*, all from China.—Ningpo, Chekiang (AMNH), eight, (BM), seven, (MCZ), two, (CNHM), two; Fuching Hsien [Futsing], Fukien (AMNH), 53, (MCZ), six; (CNHM), four; Yenping, Fukien (AMNH), six, (CNHM), two; Chungan Hsien, Fukien (AMNH), four; Kushan [Kaoshanshih] near Foochow, Fukien (USNM), one; "Peiliang," near Foochow, Fukien (USNM), one; Foochow [later Minhow] (CNHM), one, (BM), six; "Fukien" (NR), one, (CNHM), six; "Ah Chiung," Fukien (BM), three; "Mayhos," China (BM), one; Pootoo I. [Putu Shan], Chusan Archipelago, Chekiang (BM), one.

*Pelage color*.—The series of eight topotypes of *ningpoensis* in the American Museum of Natural History is consistently lighter colored in dorsal pelage than the majority of the 63 specimens from several localities in Fukien Province. While the range in ventral pelage color is very similar between the Ningpo and the Fukien material, the frequency of the palest color, about Apricot Buff, in the Ningpo is 50 per cent and in the Fukien three per cent. The richest ventral pelage color in the Ningpo eight is about Ferruginous, occurring in three specimens. Forty-one per cent of Fukien AMNH specimens have a richer pelage than Ferruginous, the richest color attained being about Sanford's Brown.

In 16 per cent of the AMNH Fukien series there is a longitudinal midventral band of gray agouti pelage entirely bisecting the red pel-

age. In 56 per cent there is an agouti wedge on the throat and breast dividing only the anterior portion of the red pelage. In 30 per cent there is no division of the red pelage. Of the eight Ningpo specimens five have an agouti wedge and three no division at all. The ventral pelage of the Tunglu series of nine at the Museum of Comparative Zoology is generally about Sanford's Brown with one about Orange Cinnamon (XXIX) and another Ochraceous Buff (XV), although the AMNH Tunglu specimen is quite as pale as *styani*, Light Ochraceous Buff at its richest.

It should be said that material included in this subspecies seems to have six black bands to the fully grown-out tail hairs, besides the hardly noticeable blackish tip. And black-tipped guard hairs with three (as well as two, one, and no) light bands, occur commonly in the dorsal pelage.

*Discussion.*—A pale subterminal band on the tail hairs is so long and noticeable that it gives a strong impression that the tail hairs are pale-buff tipped. The terminal hairs of the tail are each black for most of their length proximal to the mentioned subterminal light band. This creates a sub-subterminal black spot in the tail. This spot is particularly noticeable from the under side and quite like that found also characterizing *gordoni* and *michianus*. It rarely shows any disposition to spread onto the sides of the tail as is seen in *hendeei* and *castaneoventris*. This black tail spot thus suggests closer relationship of *ningpoensis* to *michianus* (and through it to *zimmeensis* and *gordoni*) than to the subspecies *bonhotei* and *gloveri* north of the Yangtze Kiang. The above evidence of relationship finds striking support in the common possession by *ningpoensis*, *michianus*, *zimmeensis*, and *gordoni*, of the agouti wedge on the breast or a full-length midventral agouti band. North of the ranges of these four subspecies, *gloveri* and *bonhotei* each have undivided red ventral pelage and uniformly colored tail. To the south of the same four subspecies, the agouti wedge on the breast (as well as the full-length midventral agouti band) becomes scarce in *castaneoventris* and absent in *hendeei*. Correspondingly, the tails of these two subspecies are distinguished from the black spot characterizing *ningpoensis*, *michianus*, *zimmeensis*, and *gordoni*. In *hendeei* and *castaneoventris* black is not confined to a terminal spot but extends anteriorly along each outer edge of the tail, progressively diminishing anteriorly.

### ***Callosciurus flavimanus taiwanensis* (Bonhote)**

*Sciurus taiwanensis* Bonhote, 1901, Ann. Mag. Nat. Hist., (ser. 7), 7, p. 165.

*Sciurus taiwanensis centralis* Bonhote, 1901, Ann. Mag. Nat. Hist., (ser. 7), 7, p. 166.

*Sciurus taiwanensis roberti* Bonhote, 1901, Ann. Mag. Nat. Hist., (ser. 7), 7, p. 166.

*Callosciurus erythraeus nigradorsalis* Kuroda, 1935, Jour. Mammal., 16, p. 281.

*Types*.—*S. taiwanensis*, BM No. 94.11.22.5, adult male from Baksa, Formosa, collected October 20, 1893, by P. A. Holst; *centralis*, BM No. 94.11.22.4, adult female from Lak Ku Li, central Formosa, collected June 29, 1894, by P. A. Holst; *roberti*, BM No. 62.12.24.13, adult male from northwest Formosa, collected by Robert Swinhoe (skin only); *nigradorsalis* (not seen), Marquis Yamashina Collection No. 22, adult female from Riran, Taito, southeast Formosa, collected August 1, 1932, by H. Orii.

*Material examined*, all from Taiwan (Formosa).—Teraso [Teraso Soan] (AMNH), two; Chip Chip (AMNH), three; Mt. Arisan, 8000 feet (MCZ), one, (BM), four; Kagi District (CNHM), three; "Formosa" (UMMZ), three; Tainan (UMMZ), one; Racu Racu [Rakuraku] Mountains, 7000 feet (BM), two; Tapposha [Tappan-sha], Central Formosa (BM), five; "Ho Ho Mountain," 5000 feet (BM), one; "Lak-ku-li," Central Formosa (BM), three; Baksa (BM), one; "Lau Long" (BM), one; South Cape of Formosa (BM), two; Nan-Tou Hsien, Wu-Sheh (AMNH), one; Ping Tung (AMNH), one; Taipei Hsien, Wu Lai, 16 miles south of Taipei (AMNH), five; "I-Lan Hsien," Chiao-chi (AMNH), two; Taipei (AMNH), one; "Taipei Hsien," Ping Ling, Taipei (AMNH), five; I-Lan Hsien, I-Lan, Taipei (AMNH), two.

*Discussion*.—Bonhote (1901) described three Formosan forms (of *flavimanus*) from only three localities and apparently very few, if any, more than three specimens. Furthermore, the localities from which Marquis Nagamichi Kuroda (1935, pp. 280-282) reported specimens in support of Bonhote's concepts are exceedingly few: one for *roberti*, two for *centralis*, one for *taiwanensis*, and two for the subspecies he himself proposed, *nigradorsalis*. Kuroda did have, and enumerate, at least modest series from these localities, and does to some extent describe the variation noted in his series. The material that we have been able to examine, however, does not support all of Kuroda's findings.

The only Baksa we find is about 95 miles north of the southern tip of Taiwan. We presume this Baksa to be the type locality of *taiwanensis*. This type locality is farther north than the entire known range of *nigradorsalis*, although Kuroda says that *taiwanen-*



sis "is found only in the southernmost parts of the island" implying south of the range of his *nigridorsalis*. If Kuroda's implication is correct, *thaiwanensis* would appear to be restricted to the peninsula of the southern cape, failing by 40 or 50 miles to reach its own type locality. Kuroda (1935) did not establish whether *thaiwanensis*, in his restricted concept, may in fact extend from the south peninsula westward along the south coast and then northward toward Baksa. The specimen from Ping Tung, having a red venter, strongly suggests that the gray-bellied population does not so extend westward and northward. If the locality we find for Baksa is the correct one, the type is therefore but a variant specimen from well within the geographic range of the *centralis* population. This concept of the type is supported by the other Baksa specimen in the British Museum which one of us (Tate) found to be like the *centralis* population. The above four specimens from Teraso and South Cape support Kuroda's finding that a population exists on the South Cape in which the venter is consistently (May, November, January) all gray or has but small patches of reddish at the bases of the limbs.

The greatest known distance between two localities from which only the grey-bellied south cape population is known, is between the "South Cape" and Koshun, ten miles. The distance between the only two known localities for *nigridorsalis*, Taito and Daibusan, is thirty miles. Only one specific locality has been attributed by a taxonomist to the dorsally reddish subspecies *roberti*, that is, Taiheizan. This reddish infusion is quite evident in one male specimen from Taipei Hsien, Ping Ling, but absent from two other males taken there the same day. The reddish infusion is quite evident in two specimens from Taipei Hsien, Wu Lai, but not in four others from the same place. The alleged differences between all these subspecies may be geographically constant enough over a large enough range to merit recognition as respectable geographic subspecies, but it seems to us that the constancy in some cases and the range in all remains to be demonstrated.

*Diagnosis*.—Bonhote (1901, p. 165) pointed out certain features that characterize all *C. flavimanus* on Formosa, and which may be altered to read: (1) Hairs of the dorsal pelage have 2 or 3 light bands. (2) The ears are somewhat orange on the concave surface. (3) The tail is agouti (with 3 to 5 blackish bands on each hair) for the proximal half-length but blackens progressively out the distal half, where it also has on each hair a long, yellowish tip. (4) In addition, the variation in ventral pelage is like that described above for *castaneo-*



*ventris* except that the percentage of each kind of variant differs. In a sample of 23 skins four have red throats and no, or virtually no, agouti in the midline, eleven have agouti throat and breast wedge, six have complete midventral bisection of the red by an agouti line, and two have no, or virtually no, red. (5) There is a strong tendency for the feet to be either black or blackish agouti.

Numbers 1, 2, and 5 above are characters widespread in the species *flavimanus* and emphasize this relationship. Numbers 3 and 4 particularly emphasize relationship to subspecies *castaneoventris*, not to the geographically nearer *ningpoensis*.

### **Callosciurus ferrugineus** (F. Cuvier)

*Sciurus ferrugineus* F. Cuvier, 1829 Table General et Methodique (appended to Geoffroy St. Hilaire and F. Cuvier, Histoire Naturelle de les Mammiferes, 3, p. 238).

*Sciurus keraudreni* Lesson, 1830, Centurie Zoologique, pl. 1 and text.

*Types*.—*S. ferrugineus*, not found at MNHN in 1951, collected by Duvaucel "from India"; *keraudreni*, not found at MNHN in 1951, taken in Pegu, Burma.

*Material examined*, all from Burma.—Mt. Popa, 4960 feet (AMNH), seven, (BM), four; "Kodugwe," Pegu Yoma (AMNH), three; "Yetho River," Pegu Yoma (AMNH), two; "Owegoo District," Pegu Yoma (BM), one; Chaunglon, Tkyauilla District (BM), one; Daingmhu, 200 feet, 40 miles north of Pegu (BM), two; Gokteik, 2133 feet, northern Shan states (BM), one; Kaing River, S. Pyinmana (BM), two; Lawksawk State (BM), one; "East India" (MCZ), two; 700 feet, northern Zamaya Reservation, 70 miles north of Pegu (BM), one; 300 feet, southern Zamaya Reservation, 60 miles north of Pegu (BM), one; Rangoon (MNHN), one, (BM), five; "Tankton," Rangoon (BM), one;

*Definition*.—*Callosciurus ferrugineus* is here regarded as monotypic (but including a named form *keraudreni* which may prove to occur west of the lower Irrawaddy and to be a good subspecies) and occurs only in Burma and principally between the Sittang Valley and the lower Irrawaddy. See the mapped distribution in Figure 14.

*Diagnosis*.—The dorsal pelage of *Callosciurus ferrugineus* is all a glossy, rich, dark red except that it darkens to blackish on the feet, and that in the tip of the tail there is a small tuft of white hairs. The ventral pelage is entirely a lighter red than the back. These characters distinguish *ferrugineus* from all other species of *Callosciurus*.

*Relationships to other species.*—It is obvious that the wholly red squirrels, *ferrugineus*, which live in the forests of the Pegu Yoma of Burma above Rangoon (see fig. 14) very closely resemble the wholly red squirrels of Thailand, Cambodia, and Laos. Nor can it be regarded as surprising that earlier authors (Ellerman, 1940; Ellerman and Morrison-Scott, 1951) have placed them in a single species. Their present ranges as known to us from collected specimens, are some 200 miles apart (see fig. 14) and separated by one great river barrier, the Salween. (Geologically earlier these separately evolving red squirrel populations must have been separated also by the combined Irrawaddy and Sittang rivers, as will be discussed in detail below).

The orange-footed form *C. erythraeus sladeni* of upper Burma closely resembles the orange-footed *C. f. flavimanus* of Laos and Vietnam and is separated from it by more miles and one more barrier river, the Mekong, than *C. ferrugineus* is from the all red [*C. finlaysoni*] *menamicus* of northern Thailand. But since *C. e. sladeni* and *C. f. flavimanus* are shown above to be separately evolved, one might anticipate something of the same sort of separate origin of the all red *ferrugineus* from that of the all red *menamicus*, *williamsoni*, and *cinnamomeus*.

Chhibber (1934) reports that the Chindwin and Irrawaddy were formerly quite separate rivers and that a small lateral branch of the Chindwin must have by head erosion performed an act of stream piracy which diverted the whole upper Irrawaddy north of Mandalay westward into the Chindwin. The former lower course of the Irrawaddy River was clearly down the Sittang Valley almost straight south from Mandalay to the sea. See, for example, de Terra's (1944, p. 71) sketch map of the physiography of upper Burma. Chhibber (1934, p. 20) implies that this piracy occurred after certain geological events which "characterised the close of the Tertiary . . ."

Prior to the piracy performed by the Chindwin, then, the Chindwin and Irrawaddy held between them a narrow strip of land consistently about 100 miles wide and at least 650 miles long, from the Tibetan Plateau to the sea. In the upper 50 miles of this strip the squirrel species *Callosciurus erythraeus* is a gray agouti dorsally and red only on the venter (*intermedius*). Southward from there the species descends from the mountains to forests of the wide valleys, and the pelage of the rostrum, feet, and tail are red (*sladeni*). The southernmost known specimens of *sladeni*, from Yin (about 22° 43' N.), are very red.

It seems a most reasonable hypothesis that in the 400-mile length of this inter-riparian strip remaining south of Yin, the population of these squirrels became redder until entirely red. When the stream piracy was accomplished by the Chindwin, then, the wholly red population would have become cut off completely from contact with any population with which it could interbreed. It seems probable that enough further differentiation has taken place in *ferrugineus* during this isolation that interbreeding would no longer take place if natural access to the adjacent population of *sladeni* were restored. No entirely red specimens are known from north of the new river barrier.

While the stream piracy barred *ferrugineus* from spreading to the north, it opened an area to the east across the empty former bed of the Irrawaddy. It is interesting to note that *ferrugineus* has spread across this barrier very little. Of the 13 collecting localities from which we have examined specimens, only two are across this former barrier: Gokteik and Lawksawk. No specimens which might be intergrades between *ferrugineus* and either *shanicus* or *phayrei* are known to us, although specimens of all three forms are now known from the single collecting locality of Gokteik. No evidence at all is known that *C. flavimanus shanicus* has crossed the former barrier to the west. Possibly its ecology is too specialized. Better details from the field on both geographical and ecological distribution of *ferrugineus*, *phayrei*, *shanicus*, and *janetta* on both sides of the broken barrier would be interesting.

*Pelage color.*—The dorsal pelage is generally a glossy Morocco Red, mid-dorsally deepening to about Claret Brown. The tail is Maroon, and within its tip a small cluster of white hairs regularly occurs. Ventral pelage is also red but a little lighter, about Mahogany Red in most specimens but as light as Burnt Sienna in some. The dorsal pelage color extends onto the feet but darkens near the digits which are almost black. It is the blackish feet and white tuft of hair in the tip of the tail that distinguish *ferrugineus* from the all red squirrels of the species *finlaysoni*.

*Discussion.*—Lesson's plate of *keraudreni* indicates a much greater length of the white tail tip than is the case in *ferrugineus*. There is in the British Museum a specimen, No. 79.11.21.644, which is labeled "*keraudreni*." It is from Arakan in west Burma, and this may provide a notable westward extension of the species. Almost two inches of the tip of its tail are white. It thus agrees substantially with Lesson's plate and differs somewhat from true *ferrugineus* in which the white tip is very much smaller. Confirmation of the occurrence of



dark-footed, all red, squirrels occupying a geographic area east of the present lower course of the Irrawaddy in forest of the Arakan district, especially if the long, white tail tip is characteristic of it there, would justify recognition of *keraudreni* as a subspecies of *ferrugineus*.

Nothing that the writer has seen in southern material of *C. erythraeus erythrogaster* suggests intergradation farther south with a red subspecies. However, no barrier is known to prevent such intergradation now or formerly, and the area in the Arakan Yoma from which no specimens have been studied and whence evidence of intergradation might yet be obtained, is quite large (fig. 13). If there is a geographic population of red squirrels south of the range of *erythrogaster*, its true relationships will remain uncertain until someone can show evidence that it does or does not intergrade with *erythrogaster*. Lacking such evidence, we are assuming that if a red population does live there, it became transferred west of the main barrier of the Irrawaddy in the delta by a shift of the main flow to a more eastern channel, and subsequent silting up of the old channel until it could be crossed through vegetation by squirrels. We recognize that species level differentiation of *C. ferrugineus* from *C. erythraeus* is tenuous and hypothetical.

Field observations by an experienced field collector are available: "On Mt. Popa this species only occurred in the thick jungle on the higher slopes of the mountain. Seen from a distance in a tree it appears black, the white tail tip showing up conspicuously." (G. C. Shortridge in Wroughton, 1915a, p. 473.)

### ***Callosciurus finlaysoni* (Horsfield)**

*Definition.*—The species *Callosciurus finlaysoni* is constituted by subspecies *finlaysoni*, *folletti*, *trotteri*, *frandsoni*, *albivexilli*, *harmandi*, *germaini*, *nox*, *cinnamomeus*, *annellatus*, *williamsoni*, *menamicus*, *sinistralis*, *bocourti*, and *boonsongi* (and see their synonymies). This species occupies the forests of Thailand, Cambodia, and the part of Laos along the Mekong as shown in Figure 14.

*Diagnosis.*—There are populations of this squirrel with entirely white pelage, other populations with entirely black pelage, and still others with entirely red pelage, and there is no single character now known to be diagnostic for the species. Table 8 shows the dimensions of some type specimens of forms here included in the species *finlaysoni*, and the color characters are discussed in the subspecies accounts.



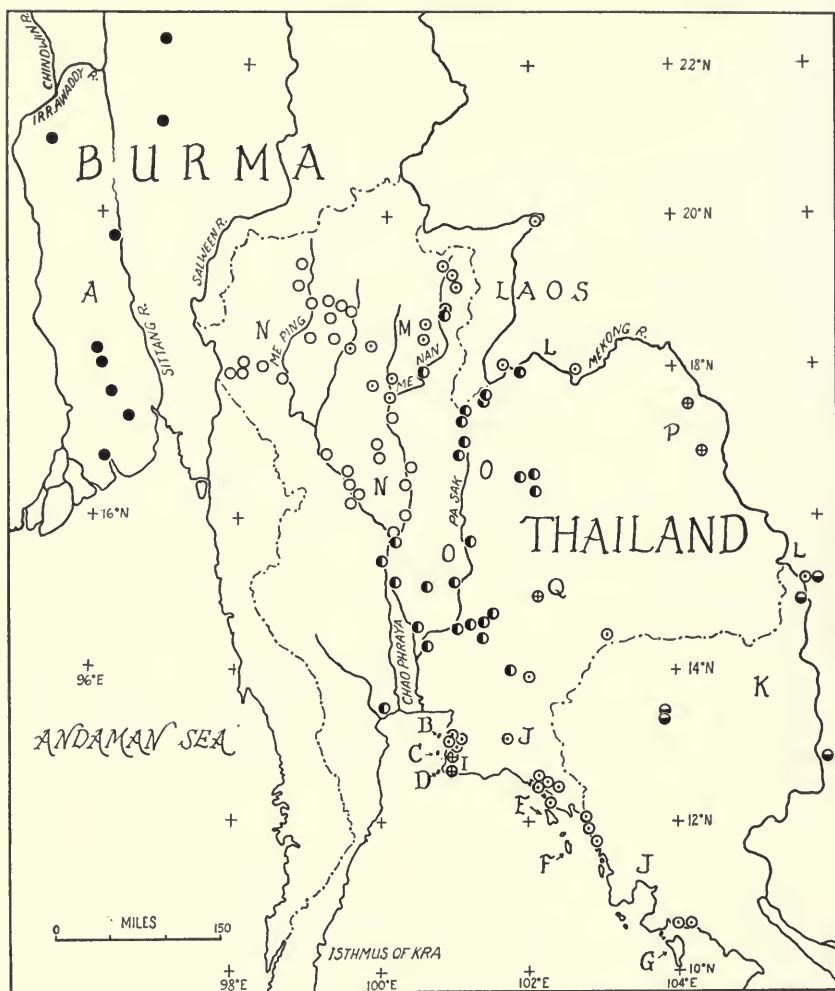


FIG. 14. Geographic distribution of two species, the Pegu red squirrel, *Callosciurus ferrugineus*, A, and the Thailand tree squirrel, *Callosciurus finlaysoni*, B to P, as plotted from material examined. Subspecies of *finlaysoni*: B, *finlaysoni*; C, *folletti*; D, *trotter*; E, *frandseni*; F, *albivexilli*; G, *hardmandi*; (off the S. E. corner of the map about 80 miles SSE on a small island is) *germaini*; I, *nox*; J, *cinnamomeus*; K, *annellatus*; L, *williamsoni*; M, *menamicus*; N, *sinistralis*; O, *bocourti*; and P, *boonsongi*.

*Relationships to other species.*—There is in Thailand, Cambodia, and Laos a complex of squirrels so extraordinarily differentiated that their variation has to be seen to be believed. Judging by collections, various local populations of it exhibit pelage that is entirely white, other populations entirely red, others entirely black, black above with white below, and other more complicated patterns. About 28 to 30 subspecies names have been applied to color variations of this presumed species.

After having studied the outstanding collection of squirrels of this complex in the United States National Museum listed in the following pages, and having plotted as carefully as we could the many collecting localities of it, we feel that this has substantially advanced understanding of these squirrels, but that a great deal of mystery remains to be dispelled. We feel that we have improved knowledge of this complex not by discovering what its true relationships are, but by showing better how some of the problems need to be attacked locally in greater detail.

Thus, even though we accept *finlaysoni* here as a species, it is provisionally and with some serious reservations. Its red subspecies *williamsoni* may quite well intergrade with *C. flavimanus flavimanus*, but evidence that it does is scanty (see figs. 13 and 14). There are indications that *C. finlaysoni sinistralis* crosses (or intergrades?) with *C. flavimanus thai*, but just north of the range of *thai*, *sinistralis* seems to occur sympatrically with *C. flavimanus zimmeensis* or to interdigitate with it in a substantial area where no evidence of interbreeding has come to our attention.

*Callosciurus finlaysoni* is one of the species reported earlier to possess but two pairs of functional mammae (Moore, 1961a, p. 14) before the present revision of this species was accomplished, and it may be worth mention that no exceptions to this were observed in the larger series at the United States National Museum during this revision. The following two records of brood size hint that in *finlaysoni* brood size may also be small. Bonhote (1901b, pp. 53, 54) notes one specimen from above Uttaradit on the Mae Nan that would now be known as subspecies *menamicus*, which was taken "pregnant with two young" on April 3, 1900; and another specimen which would now be known as subspecies *sinistralis* which was "pregnant with two young" when taken on February 3, 1900, at Kamphaeng Phet on the Mae Ping.

This species *finlaysoni* is for the most part a tree squirrel of the lowland forests. It is rather small, and it shares nearly all of its

TABLE 8. Dimensions of Some Type Specimens of the Species *Callosciurus finlaysoni*

NAME	BODY			SKULL					
	Head & Body	Tail	Hind Foot	Total Length	Masked Breadth	Nasal Length	Diameter	Palate Length	Maxillary Tooth-row
<i>finlaysoni</i>	220 ±	160 ±	46	45.5	19.0	13.0	10.5	22.6	8.8
<i>portus</i>	197	183	47.5	46.5	20.2	12.4	10.7	23.3	9.2
<i>folletti</i>	192	177	44	45.8	19.7	12.9	9.8	22.2	8.5
<i>trotteri</i>	188	172	46	47.2	19.2	13.9	10.6	23.0	9.3
<i>fransdoni</i>	235	205	57	56.3	24.0	18.2	12.8	28.0	10.8
<i>albiverrilli</i>	224	210	54	55.0	22.5	15.0	12.4	27.2	10.4
<i>pierrei</i>	240 ±	200 ±	54	....	....	16.8	12.5	27.6	....
<i>germaini</i>	200 ±	200 ±	47 ±	....	....	14.7	11.5	24.1	9.1
<i>nox</i>	207	164	54	52.3	22.6	16.2	11.9	25.1	9.7
<i>splendens</i>	230 ±	170 ±	57	....	....	17.4	12.9	27.7	10.5
<i>cinnamomeus</i>	210 ±	160 ±	46	....	21.3	15.1	12.2	24.0	10.0
<i>annellatus</i>	215	215	56	52.6	22.2	16.2	12.3	26.1	10.0
<i>williamsoni</i>	215	254	58	57.2	24.2	17.0	12.7	27.8	10.9
<i>menamicus</i>	220	236	56	55.0	22.4	16.2	13.2	26.9	10.2
<i>sinistralis</i>	191	177	47	48.3	20.2	14.6	10.4	24.0	8.8
<i>dextralis</i> <sup>1</sup>	206	184	52	51.3	21.8	14.3	11.8	26.0	9.2
<i>lylei</i> <sup>1</sup>	213	200	52	50.0	21.7	14.6	10.2	23.9	9.6
<i>gruti</i>	214 <sup>2</sup>	229	60	55.1	22.9	17.2	11.8	26.5	10.0
<i>bocourti</i> <sup>1</sup>	190 ±	180 ±	46 ±	....	....	14.2	10.4	22.2	....
<i>leucogaster</i>	200 ±	145 ±	45 ±	....	....	13.6	10.2	22.0	8.3
<i>leucocephalus</i>	196	198	49	....	20.7	....	11.5	23.0	9.1
<i>floweri</i>	190	170	46	....	28.7	19.7	13.2	21.0	8.5
<i>tachardi</i>	229	229	58	57.5	24.4	15.7	14.0	27.6	10.5
<i>cockerelli</i>	190 ±	210 ±	52	51.5	22.0	....	11.7	25.0	9.4

<sup>1</sup> The types of *dextralis*, *lylei*, and *bocourti* were young adults.<sup>2</sup> Measured from nose to anus.

range with another species of generally lowland tree squirrel, *Callosciurus caniceps* which is a somewhat larger animal. The latter does not appear, however, to be sympatric with the *finlaysoni* subspecies *cinnamomeus*, *annellatus*, and *williamsoni*.

### **Callosciurus finlaysoni finlaysoni** (Horsfield)

*Sciurus finlaysoni* Horsfield, 1824, Zoological Researches in Java, No. 7, seventh unnumbered page of text.

*Sciurus finlaysoni portus* Kloss, 1915, Jour. Nat. Hist., Soc. Siam, 1, p. 158.

*Types*.—*S. f. finlaysoni*, BM No. 79.11.21.521, old male from Koh Si Chang, Gulf of Siam, collected by George Finlayson; *portus*, BM No. 15.11.4.54, adult male from Koh Si Chang collected January 26, 1915, by C. B. Kloss.

*Material examined*.—Koh Si Chang, Gulf of Siam (CNHM), two; (BM), nine, (USNM), 22.

*Pelage color*.—Description from Kloss (1915a, p. 158): "Ivory yellow throughout, most intense on the upper surface and tail but paler, almost white, on sides of head, chin, and forelimbs. Skin of nostrils, lips, ears, soles of feet, and genitals black. Eyes black. Vibrissae black" (in the type but see below).

*Discussion*.—Wroughton (1908, p. 398), as first reviser of *finlaysoni*, stated that "The type locality is the island of Sichang." Kloss (1915b) ignored this as if a matter of opinion and tried to show that specimens of *finlaysoni* originally obtained on the mainland of Siam were intended by Horsfield to represent the new species and that mention that one specimen of the type series was from Koh Sichang was purely incidental. In consequence, he named the Koh Si Chang squirrel *portus*. Robinson (1916, p. 35) points out that Wroughton's restriction of the type locality to the island of Sichang is type designation by the first reviser. Robinson has been followed by other authors on this matter, including Kloss (1919, p. 368).

*Habits*.—Kloss's (1915a, p. 158) remarks seem well worth quoting: "I found *S. f. portus* very common on Koh Si Chang and very fearless. Its small size is due to its insular habitat and to the poverty of the vegetation, large scrub rather than forest, with which the island is covered. It runs busily about the stems and branches, often almost descending to the ground, in its search for food. The pelage of many of the animals obtained is considerably abraded and in every case has a sticky feeling very different from the smooth glossy hair of other squirrels, while both as skins and in the flesh a peculiar characteristic odour attaches to them.



"In the series a number of animals have black vibrissae like the type, in an equal number the vibrissae are pure white, while some have them black and white mixed. In about half the series the hairs of the distal half of the tail are black tipped."

**Callosciurus finlaysoni folletti** (Kloss)

*Sciurus finlaysoni folletti* Kloss, 1915, Jour. Nat. Hist. Soc. Siam, 1, p. 159.

*Type*.—BM No. 15.11.4.73, old female from Koh Phai, an island 15 miles south of Koh Si Chang, Gulf of Siam, taken February, 1915 by collectors of C. B. Kloss.

*Material examined*.—Koh Phai, Gulf of Siam (USNM), 12, (CNHM), 1, (BM), 12.

*Pelage color*.—A small white squirrel, the hairs white-tipped throughout, but with bases gray, the gray showing through the white to give an appearance of dirty white or even grayish white. This can at best be only *very slightly* different from the form on Koh Si Chang. A tendency is seen for a wash of red to appear on under parts, especially in females.

**Callosciurus finlaysoni trotteri** (Kloss)

*Sciurus finlaysoni trotteri* Kloss, 1916, Jour. Nat. Hist. Soc. Siam, 2, p. 178; *ibid*, 3, p. 369.

*Type*.—USNM No. 236601, adult male from Koh Lan, an island 10 miles south of Koh Phai, Gulf of Siam, collected by C. B. Kloss on October 29, 1916.

*Material examined*.—Koh Lan, Gulf of Siam (USNM), 9; (CNHM), 1.

*Pelage color*.—This is a white-tailed, gray-bodied, squirrel with blackish extremities and a rather faintly expressed *atrodorsalis* mark (the posterior two-thirds of the mid-dorsum blackish in a band 30 or 40 mm. wide). The gray dorsal pelage is composed of hairs that are whitish (Pale Olive Buff) on their distal half and neutral gray basally. The basal gray shows through. The limbs and sides of head and neck are gray slightly tinged with brownish, and the limbs darken distally to slightly agouti blackish hands and feet. The ventral pelage is also grizzled gray but has whitish inguinal and axillary spots. The tail is whitish above with an inner tuft of hairs among the especially long hairs of the tail tip black, and whitish below except for the very bases of the hairs which are blackened in most of the specimens.

**Callosciurus finlaysoni frandseni** (Kloss)

*Sciurus ferrugineus frandseni* Kloss, 1916, Proc. Zool. Soc. London, 1916, p. 46.

*Type*.—BM No. 15.11.4.85, adult male from the island Koh Chang, southeast Thailand, collected December 12, 1914, by C. B. Kloss.

*Material examined*.—Koh Chang, southeastern coast of Thailand (USNM), nine, (BM), four.

*Pelage color*.—This is a red squirrel with gray sides. It is red on top from rostrum to tip of tail, and red throughout the ventral pelage, but the sides of the body, head, neck, and dorsal pelage of the legs are an agouti of brownish olive. The feet are red. The anterior part of the throat is gray.

Some of the mainland material included under *cinnamomeus* is quite like *frandseni*, and it may be that further collecting will show that the Koh Chang material and that on the mainland like it should be recognized as a single subspecies different from *cinnamomeus*. See further discussion of this under the subspecies *cinnamomeus*.

**Callosciurus finlaysoni albivexilli** (Kloss)

*Sciurus albivexilli* Kloss, 1916, Proc. Zool. Soc. London, 1916, p. 47.

*Type*.—BM No. 15.11.4.46, old male from Koh Kut, an island off the southeast coast of Thailand, collected December 25, 1914, by C. B. Kloss.

*Material examined*.—Koh Kut, Thailand (BM), 7, (CNHM), 2, (USNM), 11.

*Original description*.—" . . . Black throughout except the extremity of the tail, which is white . . . [This subspecies] is somewhat variable in respect of the white tail tip. In some animals the last 3 or 4 inches of the tail are white . . . in others . . . the pale tip is reduced to a bunch of grayish hairs at the extreme end . . ."

*Discussion*.—Only the constantly present (though variable in extent) white tip of the tail distinguishes this insular subspecies from *nox*. No taxonomic difference is seen between the skulls of the two races.

**Callosciurus finlaysoni harmandi** (Milne-Edwards)

*Sciurus harmandi* Milne-Edwards, 1876, Bull. Soc. Philomathique, Paris (ser. 6), 13, p. 8.

*Callosciurus ferrugineus pierrei* Robinson and Kloss, 1922, Ann. Mag. Nat. Hist. (ser. 9), 9, p. 91.

*Types*.—*S. harmandi*, MNHN No. 1876-125 (140), from Phu Quoc, south of Cambodia, collected by Harmand in 1876; *pierrei*, BM No. 78.6.17.27, an old female taken on Phu Quoc, an island off the coast of Cambodia in February 1874 by Pierre.

*Material examined*.—Phu Quoc, Cambodia (MNHN), 3, (BM) four.

There are three paratypes of *harmandi*. The skulls, from which many of the teeth have fallen, of the four animals were not marked by number. One of us (Tate) tentatively marked numbers on all four (including the type) from one to four. There seems to be no possibility that they can ever be matched to their proper skins.

*Type description*.—The color of the pelage of the type (examined in 1951) is dark reddish brown, quite heavily grizzled with whitish posterior to the nape, but the top of the head is dark brown. The tail appears whitish in over-all views, but the bases of the hairs are very dark gray, and the tail tip is dirty white. The under parts are light orange red, with bases of the hairs gray, but on the chest the red gives place to buff, and the throat is dark gray brown like the sides of the head. The relationships of *harmandi* appear to be with *sini-stralis*, although *harmandi* is geographically remote from it and a distinctly insular race.

*Discussion*.—The alleged presence of two kinds (*harmandi* and *pierrei*) of red-bellied squirrels on Phu Quoc poses something of a problem. In the first place, the known materials representing the two named forms, although very scarce, are admittedly different enough from forms on the adjacent mainland and from each other to be good subspecies. However, both of them seem definitely related to the species *finlaysoni* in their color characters, and two subspecies of a single species do not retain characters distinct from one another while confined together on an island only 30 miles long.

There seem to be at least two reasonable explanations: (1) The material described as *harmandi* and *pierrei* really all represents but one subspecies which is exceedingly variable. It is well documented that squirrels may be locally this variable (Moore, 1956). (2) The island has been invaded twice, and during the time interval between invasions the first emigrants and the nearest mainland form evolved so differently in appearance and habits that when contact was renewed during the second invasion no interbreeding took place and competition has somehow been minimized. In this case it would probably be better to regard *harmandi* as a distinct species and *pierrei* as a subspecies of *finlaysoni*.

New collecting or, at the very least, documented field study is needed on Phu Quoc to determine which of the two above conditions, or whether some other, prevails. Since double invasion seems to us the less likely situation, we have tentatively treated *harmandi* and *pierrei* as if they represent a single variable subspecies.

***Callosciurus finlaysoni germaini* (Milne-Edwards)**

*Sciurus germaini* Milne-Edwards, 1867, Rev. Zool., Paris (ser. 2), 19, p. 193.

*Type*.—MNHN No. 1865-429 (126), old adult from Pulo Condor, Cochin China, collected by R. Germain.

*Material examined*.—Pulo Condor, Cochin China (BM), 2, (MNHN paratypes), 10; "Cambodia" (BM), 1.

*Type description*.—Though the color of the typical series appears at first jet black, a trace of brown mixed with the black of the chin, neck and under parts could be distinguished in good light when examined in 1951. Possibly this is due to fading, as the specimens were collected nearly 90 years ago. In the type specimen there is also a tiny patch of hairs with whitish tips asymmetrically placed on the left of the lumbar region. Hands, feet and tail are perfectly black.

*Dimensions*.—This insular subspecies apparently may be smaller than the black mainland subspecies about Sriracha, Thailand, from Wroughton's (1908, pp. 397-398) comparative data on an adult of each: hind foot lengths respectively 42 compared to 51 mm.; greatest skull lengths respectively 47 to 53.7; greatest zygomatic breadth, 28 to 32 mm.

***Callosciurus finlaysoni nox* (Wroughton)**

*Sciurus nox* Wroughton, 1908, Ann. Mag. Nat. Hist. (ser. 8), 2, p. 397.

*Type*.—BM No. 6.10.7.4, adult male from 50 miles southeast of Bangkok, coastal Thailand at sea level, collected August 7, 1906, by T. H. Lyle.

*Material examined*, all from the mainland coast of Thailand south-east of Bangkok.—Sriracha, at sea level (BM), three, (NR), one, (USNM), four; Hup Bon [Ban Hup Bon], 500 feet (BM), two, (USNM), one; Satahip (BM), two, (CNHM), two, (USNM), six; 60 miles southeast of Bangkok (BM), two; Nongkhon [Ban Nong Kho] (USNM), 11, (MCZ), two; Ban Sadet (USNM), three; Nong Yang (USNM), one; Huey Yang (USNM), one.

*Discussion*.—It seems possible that *nox* represents a color phase of *cinnamomeus* which has evolved to a high proportion of the pop-



ulation through natural selection, possibly in dark mangrove forest. Specimens of *cinnamomeus* have been taken at five of the eight above localities, but at Sriracha and Satahip we have records of only black squirrels. It is worth noting that some selection for blackness may be taking place in the "red phase" in this area, too, since black on the feet and tail is the basis for the named form *herberti* from this vicinity.

*Pelage color*.—Description of *nox* is simple; it is jet black above and below.

### ***Callosciurus finlaysoni cinnamomeus* (Temminck)**

*Sciurus cinnamomeus* Temminck, 1853, Esquisses Zoologiques sur la Cote de Guine, p. 250.

*Sciurus splendens* Gray, 1861, Proc. Zool. Soc. London, 1861, p. 137.

*Callosciurus ferrugineus herberti* Robinson and Kloss, 1922, Ann. Mag. Nat. Hist. (ser. 9), 9, p. 90.

*Types*.—*S. cinnamomeus*, RNH No. 13367 (Temminck's specimen "C") adult from Cambodia; *splendens*, BM No. 61.4.12.10 (= Gray's variety 2), adult female from Cambodia, taken by Mouhote; *herberti*, CBK No. 2017 (not found at BM), an adult male collected at Hup Bon, near Sriracha, southeast Thailand, on July 25, 1915, by a museum collector.

*Material examined*, from Thailand.—Ok Yam (USNM), four, (BM), four; Klong Yai (USNM), eight, (BM), two; Klong Menao (USNM), one, (BM), one; Lem Ngop (USNM), two, (BM), two; Ban Sadet, Sriracha (USNM), one; Nongkhor, near Sriracha (USNM), two, (CNHM), one, (MCZ), one; Lem Sing Mountain, Chantaboon (USNM), eight; Chantaboon (USNM), four, (BM), one, (UMMZ), two, (AMNH), seven, (ANSP), four; Kao Seming, Krat (USNM), six; "Bantarn Dam" (USNM), one; Kao Sabab (USNM), 12, (CNHM), two; Nong Yang (USNM), two; Hoopbon [Ban Hup Bon] (USNM), two; "Huey Yang," Sriracha (USNM), seven; Sakeo, near Krabin (USNM), five; Khao Soi Dao, 3500 feet, S.E. Siam (ANSP), three; Kratt [Ban Kratt] (ANSP), one; "Cochin China" (MNHN), two.

*Material examined*, from Cambodia.—Bokor, 3000 feet (BM), five, (MNHN), three; Kampot, 100 feet (BM), one; Sien-reap, 150 feet (BM), four, (MNHN), two.

*Pelage color*.—In the United States National Museum collection of 47 specimens of this subspecies from southeastern Thailand, four general localities that are represented lie on a northwest-southeast

axis. The southeastern group of localities (Ok Yam, Klong Yai, and Klong Manao) is at the Cambodian border, and the northwestern group (Hoopbon, Ban Sadet, Nong Khor, Sriracha, and Nong Yang) is near the east coast of the Inner Gulf of Siam about 50 miles from the mouth of the Chao Phraya. These two groups of collecting localities are represented by samples of 13 and 12 specimens respectively. The more southern of the two middle groups (Lem Ngop and Kao Seming) is represented by seven specimens, and the other (Chanta-boon, Kao Sabab, and Lem Sing Mt.) by 24. In the sample from the most southeastern group of localities 12 of the 13 possess all red pelage. The other specimen is red except for olive agouti dorsal pelage of the cheeks, forelegs, and thighs. Of the next most southeastern seven only three are in the all red category; the other four are red except for olive agouti pelage on cheeks, forelegs, and thighs. The next northwestern sample, of 24, has 11 all red; 10 all red except for agouti cheeks, forelegs, and thighs; and three that are all red except for agouti side of head, neck, and body, and agouti fore and hind legs. The most northwestern of the four groups of localities is represented by nine all red specimens; two with all red pelage except for agouti cheeks, forelegs, and thighs; and one with all red pelage but agouti side of head, neck, and body, and agouti fore and hind legs.

*Discussion.*—Consideration of the above information suggests the general distribution of an all red form of squirrel throughout this southeastern area of Thailand with a general tendency to produce variants marked by one of two similar patterns of agouti pelage. The greatest incidence of agouti pelage in these mainland localities occurs in the two middle groups which are close to the island, Koh Chang. From that island the United States National Museum sample of nine is composed of two with all red pelage except for agouti cheeks, forelegs, and thighs, and seven all red but for agouti sides of head, neck, and body, and agouti fore and hind legs. No entirely red specimens are known from Koh Chang, and the sample from there is entirely like the two agouti variants on the mainland and preponderantly like the one with the greater amount of agouti. The insular population is here admitted as a separate subspecies, *frandseni*, and the material from the two middle groups of mainland localities is considered intermediate between *cinnamomeus* and *frandseni*. Koh Chang is very close to the mainland and separated from it by quite shallow water.

The important sample of five of these squirrels from "Sakeo, near Krabin" is not included in the above discussion, and their locality is

well north of those discussed above. (It is shown above the "J" in Figure 14.) In a general way each of these squirrels has all red pelage excepting for agouti sides of head, neck, and body, and agouti fore and hind legs. Furthermore, one specimen has an almost completely olive gray agouti back and the tail hairs banded with black near the base of the tail. Thus, the incidence of agouti in this sample is a hundred per cent, and the agouti is also more extensive per individual even than in the sample of *frandseni*.

The importance seen in the "Sakeo, near Krabin" series, however, is not in the inexplicably frequent and extensive occurrence of agouti pelage, but other characters. No. 253428 has rather whitish agouti sides resulting from very elongate subterminal white bands on the hairs. No. 253425 has very whitish ventral pelage. This is whitish agouti on chin and throat, very pale buff on the inferior sides of the legs, and buffy on the venter. There are also occasional all white hairs on the tail. These whitish aberrations in two specimens of five are, in view of the proximity of *bocourti*, considered to constitute evidence of interbreeding between *cinnamomeus* and *bocourti*.

In regard to the wholly red specimens of *cinnamomeus*, they are generally glossy and possess a broad, longitudinal, middorsal band that is notably darker than the red of the sides and legs. This is characteristic of the type of *splendens*, and distinguishes most *cinnamomeus* from *menamicus* (with which *cinnamomeus* is not in geographic contact). There are occasional specimens of *cinnamomeus*, however, that are all red and that have middorsal pelage the same color as that of the sides and legs, and with less gloss to the pelage. These are the characteristics of the type specimen of *cinnamomeus*. Examples are USNM No. 255743 from Lem Sing, 257734 from Huey Yang, and 256840 from Nong Yang.

We have seen in the small amount of material from Cambodia no evidence of intergradation between *cinnamomeus* and *annellatus*. But the white ring about the basal end of the tail in *annellatus* is the principal difference between it and all red *cinnamomeus*. Another, slighter difference is that in a specimen of *annellatus* the pelage of the back is the same red as that of the sides and venter. It would be surprising, indeed, if these two forms did not intergrade.

### ***Callosciurus finlaysoni annellatus* (Thomas)**

*Callosciurus ferrugineus annellatus* Thomas, 1929 (for 1928), Proc. Zool. Soc. London, 1929, p. 839.



*Type*.—BM No. 28.7.1.103, adult female from Ankor, 150 feet, Cambodia, collected December 24, 1927, by J. Delacour and W. Lowe.

*Material examined*.—Angkor, Siem Reap, Cambodia (USNM), one, (BM), one, (MNHN), one; Bassac, west of Mekong R., Laos (CNHM), two; "Cambodia" (CNHM), one; Sambor, 200 feet, Cambodia (BM), one; east of Paksé at 1000 feet, Laos (BM), one.

*Pelage color*.—The Chicago Natural History Museum specimens listed above are as follows: The dorsal pelage is Morocco Red, the ventral pelage is Claret Brown in two but Morocco Red in one, the tail is Victoria Lake with a sharply contrasting band of Cream Color about four centimeters long that begins about five cm. from the body. The face, feet, and wrists are darker than Maroon.

*Discussion*.—In describing the subspecies *annellatus*, Thomas (1929, p. 840) notes that it is the "variety 1" ascribed by Gray (1861) to *splendens*, and which Thomas (1929) re-examined at the time (BM specimen no. 61.4.12.9). Thomas (1929) regards Wroughton's (1908, p. 397) statement, "I have concluded to accept Gray's *splendens* var. 2 Capt. Flower's Chataboon specimen . . . as the normal of the species." as a lectotype selection. The examination of further material now makes the choice seem a quite acceptable one, and we certainly concur in it.

### ***Callosciurus finlaysoni williamsoni* (Robinson and Kloss)**

*Callosciurus ferrugineus williamsoni* Robinson and Kloss, 1922, Ann. Mag. Nat. Hist. (ser. 9), 9, p. 90.

*Type*.—BM No. 26.11.17.4, adult female taken at Khet Don Heng, below Xien Khan [Chieng Khan] on the north bank of the Paklay Loop of the Mekong River on January 31, 1920, by H. C. Robinson and C. B. Kloss' collector.

*Material examined*, all from Laos.—Vientiane (USNM), one; (MCZ), one; "Tha Ngon," Vientiane (CNHM), six; Paksé (CNHM), four.

*Discussion*.—The describers of this subspecies possessed a hypodigm of 17 specimens from localities spread 200 miles along the Laotian bank of the Mekong River from Muong Liep (about 30 miles up river from Pak Lay) to Ban Manao (longitude 104° E.). Four specimens reported here from Paksé extend the range southward along the east bank of the Mekong another 200 miles. It seems to be unknown from the other side of the Mekong.

At Paksé the ranges of *williamsoni* and *annellatus* seem to approximate, and *annellatus*, curiously, is known from both sides of the



lower Mekong. Perhaps this could have come about by naturally changing channels where the river is strongly braided beginning about 50 miles south of Paksé.

As is evident from material cited above, collecting in Laos has been meager, and from the little material available, scarcity of evidence on intergradation need surprise no one. There is a specimen of *flavimanus* (USNM No. 254753) from "Nong Kai, Laos," and if this locality may be taken to mean Laos, across the river from Nong Kai, Thailand, then this specimen is within the range of *C. finlaysoni williamsoni*. Possibly the Nong Kai specimen is, and certainly the one from the Bolovens Plateau (AMNH No. 87431) seems to be, a cross between *C. flavimanus* and *C. finlaysoni williamsoni*.

*Pelage color*.—The following description is taken from Chicago Natural History Museum materials. The Tha Ngon series (taken June 30 to July 3) have dorsal pelage that is entirely Mars Orange except the tail tip which is faded. Ventral pelage is a darker color, Chestnut, than the dorsal pelage, except for new pelage in nos. 32385 and 32390 which are molting, and 32388 which seems to have molted in parts. The Paksé series (three taken November 18 and one taken January 2) have dorsal pelage entirely Morocco Red in three and Mahogany Red in the other (a November one). The tails are Maroon and very little faded at the tip. The ventral pelage is a lighter color, Mahogany Red, than the dorsal pelage in two and a still lighter color in the other two, Sanford's Brown.

*Discussion*.—The above shows an early summer condition of darker ventral pelage than dorsal, and an early winter condition of the reverse. The molt mentioned above, which changes the venter from Chestnut, which is darker than the back, to Orange Rufus, which is lighter than the back, suggests seasonal alternation of relative intensities. The original describers' hypodigm was taken in January and February, and in it the venter is darker than the dorsum. This suggests that a second seasonal molt (in early January?) may have returned the intensity relationship to the condition lost in the June-July molt. Probably no such neatly seasonal molting will be found to exist when more is learned. The molting of *C. caniceps* is not seasonal in the available museum material.

The United States National Museum has a parous female specimen, no. 240512, taken July 2nd at Luang Prabang, Laos, which Osgood (1932, p. 280) puzzled over but did not name. He assumed that it must belong to some species with which he was not working and not familiar, such as *caniceps* or *pygerythrus*. It is definitely not

related to those, however, and examination of the evidence may show that it represents a cross between two forms with which he was then quite familiar. The specimen has an all red venter, an all red tail, and red middorsal pelage from snout to tail in a broad band covering the crown and pinnae but descending no lower on the sides. The remainder of the squirrel is cool gray agouti (sides, legs), but on the feet the gray agouti is rather strongly blackened. The red dorsum and tail are identical with *williamsoni* of Vientiane. The gray sides, the red of the venter, and the distinctively blackish agouti feet are like those of *C. flavimanus hendeei* of this vicinity. (*C. f. hendeei* is shown to intergrade with *C. f. flavimanus* perhaps 40 air miles east of Luang Prabang in the above account of the latter.) The other species of *Callosciurus* east of the Mekong in this vicinity is *C. inornatus*. See the ranges of *hendeei* and *inornatus* as "R" in Figure 13 and triangles in Figure 15, respectively. The agouti of the sides and legs is more like that of *hendeei* than *inornatus*, the blackish feet witness strongly against *inornatus* which has plain agouti feet. In undamaged skulls of *inornatus* the ectopterigoid ridge skirts the outside of the foramen ovale like a little fence, but in *hendeei* and *williamsoni* and the specimen in question, the ridge runs directly toward the foramen ovale and ends at its margin.

Across the Mekong to the west among the normally all red *C. finlaysoni menamicus* in Thailand are found specimens possessing the same pattern of red and agouti. See subspecies "M" in Figure 14. A series of these are USNM Nos. 261071 to 261074 and 267212 from Pua, Doi Phu Kha (2 specimens), Ban Na Ko, and Doi Kang Ma, respectively. These are further described below in the account of *menamicus* as crosses between *C. finlaysoni menamicus* and *C. flavimanus zimmeensis*, and the Luang Prabang specimen differs from them in having the agouti pelage of the chin blend gradually with the red of the throat as in *hendeei* rather than extending onto the throat and breast as an agouti wedge partially bisecting the red venter as is common in *zimmeensis*. There is no indication of a subterminal black spot near the end of the tail in the Luang Prabang specimen, but the tip of the tail may be missing. The color of both the middorsal and the ventral pelage in the Luang Prabang specimen is about Mars Orange, suggesting that the *hendeei* influence to lighter colored red venter altered the *williamsoni* pattern of ventral pelage differing notably from dorsal in intensity of color.

In sum, the evidence indicates that the Luang Prabang specimen almost certainly represents a cross between *C. finlaysoni williamsoni*

and *C. flavimanus hendeei*. This would indicate an extension of known range of *williamsoni* some eighty miles up the eastern bank of the Mekong.

***Callosciurus finlaysoni menamicus* (Thomas)**

*Callosciurus ferrugineus menamicus* Thomas, 1929 (1928), Proc. Zool. Soc. London, 1929, p. 839.

*Type*.—BM No. 0.10.7.11, an adult female taken from Nan, Thailand, April 3, 1900, by Thomas H. Lyles.

*Material examined*, from northern Thailand.—Den Chai (NR), one; Pak Koh (NR), two; Me Moh (BM), two; Uttaradit, 58 meters (BM), one; Lakhon, 235 meters (BM), one; Nan, 306 meters (BM), one; Ban Huai Som (USNM), two; Ban Me Mo (USNM), one; Pang Nam Un, Nan (USNM), two; Doi Pu Het (USNM), one; and Doi San Huai Wai (USNM), one.

*Material examined*, of crosses or intergrades between *menamicus* and *C. flavimanus zimmeensis* from Thailand.—Pua (USNM), one; Doi Phu Kha (USNM), two; Ban Na Ko (USNM), one; and Doi Kang Ma (USNM), one.

*Diagnosis*.—This subspecies may evidently be distinguished from other all red subspecies of the Indochinese Subregion by having the back, sides, venter, and feet entirely and equally red, and the tail red but with a buffy white tip.

*Discussion*.—The intermediates formed between this subspecies and *C. flavimanus zimmeensis* have a subterminal black spot in their red tails and their red venters partly bisected anteriorly by a posteriorly directed wedge of agouti pelage. All but the Doi Kang Ma specimen have red venters, backs, and tails, but agouti sides.

Gyldenstolpe (1916b, p. 37) noted this red squirrel "to be fairly common in the dry forests of Northern Siam," and that "No white specimens were obtained or observed during the whole journey." He took only two specimens of this red form, both about Pak Koh where (Gyldenstolpe, 1916a, p. 5) he spent a month in March and April, and wrote that "The mixed dry forests are . . . the most predominant in the low-lying country and on the lower hills." Deignan (1945, p. 25) agrees that the "Mixed-deciduous [forest is] an association highly developed at low elevations in the larger valleys of our [North Thailand] provinces . . ."

The hypodigm of two specimens from Doi Souket on which the name *primus* (synonym of *C. flavimanus zimmeensis*) is based is, in



view of the present knowledge of the geographic ranges of these squirrels, probably evidence of interbreeding between *zimmeensis* and *menamicus*. They are closer to the former, having only reddish ears and nape and red posterior half of the tail as suggestive evidence of relationship to *menamicus*. (The undivided venter may be found occasionally elsewhere in the sample of *zimmeensis*.)

This interbreeding is between a tropical montane form (*zimmeensis*) which in this artenkreis is characteristically agouti gray-olive-brown dorsally, and a tropical lowland subspecies (*menamicus*) which in this artenkreis tends to be more brilliantly colored dorsally. It thus seems appropriate that the type of *primus* should be from a river bank at 1500 feet, but that the other specimen should be labeled 6500 feet is surprising. (Deignan, 1945, p. 17, gives the elevation of Mt. Souket as only 5,958 feet, but it is not the disagreement of 500 feet that seems significant.)

The United States National Museum specimen from Luang Prabang has a red dorsum from snout to tail, a red tail, and an undivided red venter, but the sides, legs, and feet are strictly agouti. The agouti sides are separated abruptly from the red dorsum and red venter alike. This specimen seems in color characters so much like the Pua and Doi Phu Kha intergrades between *menamicus* and *zimmeensis* that one could think it must have been taken on the west side of the Mekong opposite Luang Prabang. See the discussion of it above in the account of *williamsoni*.

### ***Callosciurus finlaysoni sinistralis* (Wroughton)**

*Sciurus bocourti sinistralis* Wroughton, 1908, Ann. Mag. Nat. Hist. (ser. 8), 2, p. 399.

*Sciurus bocourti dextralis* Wroughton, 1908, Ann. Mag. Nat. Hist. (ser. 8), 2, p. 400.

*Sciurus bocourti lylei* Wroughton, 1908, Ann. Mag. Nat. Hist. (ser. 8), 2, p. 401.

*Sciurus bocourti gruti* Gyldenstolpe, 1917, Handl. Kungl. Svenska Vet. Akad., 57, no. 2, p. 37.

*Types*.—*S. b. sinistralis*, BM No. 3.8.5.8, adult male from Kampong below Pichit (on Me Nam River), 35 meters, Siam, collected June 8, 1903, by T. H. Lyle; *dextralis*, BM No. 0.10.7.9, young female from Kampeng [Phet] on the Me Ping, Thailand, taken February 3, 1900, by T. H. Lyle; *lylei*, BM No. 7.11.13.11, young adult female from Chiangmai, Me Ping River, Thailand, collected August 12, 1907, by T. H. Lyle; *gruti*, NR No. 15, adult female from Bang Hua



Pong on the southern slopes of Doi Khun Tan, north Thailand, collected on May 8, 1914, by Nils Gyldenstolpe.

*Material examined*, all from Thailand.—Doi Lang Ka (USNM), one; Raheng, 110 meters (USNM), two, (BM), two; Kuhn Tan (USNM), eight, (ANSP), one, (NR), three; "B. Nam Kien," Nan (USNM), one; Pang Me Ton (USNM), two; Klong Klung (USNM), seven; Doi Phra Chao (USNM), six; Nakon Sawan (USNM), one; Wung Pratart Farm (CNHM), 16; 20 miles east of Chiang Mai (ANSP), one; 35 and 40 miles above Pichit (BM), two; Phitsanuloke, 47 meters (BM), four; 160 miles north of Bangkok, 32 meters (BM), one; Bon Mee, Siang Hai, 90 meters (BM), one; "Banthee," Siang Hai, 90 meters (BM), one; above Kampeng on the Meeping River, 115 meters (BM), one; Meeping River, 65 meters, 180 miles north of Bangkok (BM), one; Sokotai, 64 meters (BM), two; Bang Hue Pong (NR), three; Paknampo (USNM), one; Meping River, 18° N. latitude, 310 meters (BM), one; south of Chiangmai, latitude 18° 30' N., 260 meters (BM), one; Doi Mei Lai (USNM), one; Doi Me Kong Kha (USNM), two; Chiang Mai (USNM), two; Doi Nang Keo (USNM), one; Doi Chiang Dao (USNM), one; Doi Kang Ma (USNM), one; Pua (USNM), one; Doi Phu Kha (USNM), two; Ban Na Ko (USNM), one.

*Pelage Color*.—The fine series of sixteen at Chicago Natural History Museum from Wung Pratart Farm, Kamphaeng Phet Province have undivided Mahogany Red venters except for one being Sanford's Brown. On the head, wrists, ankles, and ears the pelage is red, about Hays Russet. The feet are an agouti of about Carob Brown (XIV). At first inspection the dorsal pelage does not appear to be agouti, but rather a random mixture of white hairs with red hairs and black hairs. Closer inspection reveals the "red" hairs to be black hairs with one or two reddish bands. The effect of the admixture of white hairs produces a more pronounced grizzle than one finds in most agouti pelages. The pelage of the back extends out the tail about 40 mm. Then there is a cream colored band 30 mm. wide across the tail, and beyond it the tail is pure Morocco Red in most. In some, however, the tail hairs are annulated black and white near their bases instead of entirely red.

*Diagnosis*.—Near the base the tail is whitish for 30 or 40 mm. and beyond that Morocco Red, but the pelage of the dorsum varies from reddish agouti with many white or gray guard hairs to completely gray pelage.

*Discussion.*—The above pelage color description is very similar to Wroughton's original description of *dextralis*, but more detailed, and the locality is not far from the type locality of *dextralis*.

Near the northern extremity of the range of the present subspecies at Khun Tan, ANSP No. 15301 has an undivided venter of Orange Rufous and dorsum of about Mouse Gray, and the tail, beyond the basal whitish ring (30 or 40 mm. long), is Morocco Red. The head and nape are Orange Rufous with a liberal sprinkling of gray guard hairs.

The Khun Tan specimen described above seems possibly by its Orange Rufous head and nape, and geographical proximity to *menamicus*, to represent intergradation with *menamicus*. USNM No. 296943 from Ban Sanping, Nakhon Sawan Province, shows definite indication of crossing or intergradation with *C. f. thai* in having a 20 to 30 mm. broad glossy black band on the posterior two-thirds of the middorsum, and otherwise possessing entirely *sinistralis* characters.

There may eventually prove to be an adequate basis for breaking up this subspecies into two: *sinistralis* and *lylei*, the former distinguished by the dorsal pelage containing black and/or brown, the latter by absence of brown in the grayish white dorsal pelage. However, strong characters link the two potential forms and distinguish them jointly from surrounding subspecies. In absence of better knowledge, therefore, it seems desirable to recognize but a single subspecies here with three synonyms.

### **Callosciurus finlaysoni bocourti** (Milne-Edwards)

*Sciurus bocourti* Milne-Edwards, 1867, Rev. Zool., Paris (ser. 2), 19, p. 193.

*Sciurus leucogaster* Milne-Edwards, 1867, Rev. Zool., Paris (ser. 2), 19, p. 196 (homonym of Cuvier, 1831).

*Sciurus leucocephalus* Bonhote, 1901, Proc. Zool. Soc. London, 1901, p. 54.

*Sciurus floweri* Bonhote, 1901, Ann. Mag. Nat. Hist. (ser. 7), 7, p. 455.

*Callosciurus finlaysoni tachardi* Robinson, 1916, Jour. Federated Malay States Mus., 7, p. 36.

*Sciurus finlaysoni prachin*, Kloss, 1920, Jour. Nat. Hist. Soc. Siam, 4, p. 103.

*Sciurus finlaysoni rajasima*, Kloss, 1920, Jour. Nat. Hist. Soc. Siam, 4, p. 103.

*Callosciurus cockerelli* Thomas, 1928, Ann. Mag. Nat. Hist. (ser. 10), 2, p. 100.

*Types.*—*Sciurus bocourti*, MNHN No. 1860-123 (135), young adult from Thailand, collected in 1860 by Montigny; *leucogaster*, MNHN No. 1862-1241 (1303-A-224), adult male from Thailand; *leucocephalus*, BM No. 0.10.7.12, adult male from Chainat, 20 meters, Me Nam River, Thailand, collected January 21, 1900; *floweri*, BM No. 99.2.-

7.1, adult female from Klong Morn, near Bangkok, Thailand, collected August 13, 1898, by S. S. Flower; *tachardi*, BM No. 0.10.7.7, old male from 75 meters, some 30 miles up the Mee Nan [river] above Uttaradit,  $17\frac{1}{2}^{\circ}$  N., Thailand, collected April 4, 1900, by T. H. Lyle; *prachin*, not seen, No. 2048 in private collection of C. B. Kloss, adult male from Krabin, central Thailand, collected November 11, 1915, by E. G. Herbert and Malcolm Smith; *rajasima*, not seen, No. 2132 in private collection of C. B. Kloss, adult female from Lat Bua Kao, Thailand, collected October 10, 1916, by C. B. Kloss; *cockerelli*, BM No. 28.5.5.2, adult from Paktoop Mountain, Nan, Thailand, collected January 1928, by Homer Wiesbecken.

*Material examined*, all from Thailand.—“Lam Ton Lang,” *Krabin* (USNM), three; “Nong Mong” Muong *Krabin* (USNM), one; Kao Lem [Khao Laem] (USNM), one; Hin Lap (USNM), six; Pang Sok (USNM), one; Pak Chong (USNM), 28, (CNHM), two, (AMNH), 15; Muek Lek (USNM), three; Nong Bua, Pasak River (USNM), one; Ban Manao Van, Pasak River (USNM), one; Manoram (USNM), one; Vichianburi (USNM), three; Bung Borapet (USNM), five; Nong Kai (USNM), one; Ban Den (USNM), one; Angton (BM), two; “Nong Dom” (UMMZ), seven; “Central Siam” (UMMZ), four; “Northeast Siam” (UMMZ), one; Lat Bua Kao (USNM), two; “Ban Den,” on the Mekong (USNM), one; “B. Hin Ngom” (USNM), one; Prapoot Mtn., Lopburi (USNM), two; Ban Non Toulek, Chaiyaphum (USNM), one; Ban Lad, Chaiyaphum (USNM), two; “Ban Kudelon,” *Chaiyaphum* (USNM), one; Pookeio, Chaiyaphum (USNM), two; Muaklek, Kaengkoi, Sraburi (USNM), one; “Tahpen Mtn.,” *Muaklek* (USNM), four; “Ban Na Nong,” Chuempae [*Ban Chum Phae*] (USNM), three; “Sawan Mtn., Ban Seio,” *Loei* (USNM), five; Ban Mung Ky [Muang Khai], Tahlee [Tha Li], Loey (USNM), 18; Lomlo Mtn., Ban Maeo Goksatawn, Dahnsai [Dan Sai], (USNM), 47; Lomloe Mtn., Ban Huie Muen, Goksatawn, Dahnsai [Dan Sai] (USNM), one; “Ban Na Muang, Na Haeo,” *Dan Sai*, Loei (USNM), 23; Ban Muang Khai, *Tha Li*, Loei (USNM), 16; Ban Nam Yen, Phak Khinak Mtn., Dan Sai, Loei (USNM), 25; Nam Lang Mtn., Ban Khok, Naphung, Dan Sai (USNM), 40; Ban Khana (USNM), one; Patoop Mountain, near Nan (BM), one; Nan (BM), one; “Tahkamen” (BM), two; Krabin (BM), one; latitude  $15^{\circ}$  N., longitude  $100^{\circ} 30'$  E. (BM), one.

The type locality, restricted to Ayutthaya by Wroughton (1908), is on the southern margin of the range of this subspecies, where its color characteristics are extremely variable. From the presently



available information the range of *bocourti* extends from the vicinity of Ayutthaya northward up the Chao Phraya Valley and the Pa Sak Valley and beyond the latter valley's northern end to the banks of the Mekong. In the mountains on each side of the upper Pa Sak the large samples collected by Robert E. Elbel and deposited in the United States National Museum reveal constancy in those extreme characters which we find mark the geographic subspecies and which are but mildly expressed in the type specimen and hardly at all in some topotypes.

*Pelage color.*—The 170 specimens of *bocourti* from eight localities near Dan Sai, Tah Li, and Loei about the headwaters of the Pa Sak are uniformly white or cream color on the entire venter, entire head, distal half of the dorsal pelage of the legs, lower half of the sides, ventral pelage of the legs and tail. The other color of this intensely pied squirrel is glossy black. The dorsum from just behind the ears and crown to a varying distance out the dorsal surface of the tail, and extending halfway down the sides and out half the length of the legs, is black.

The black of the middorsum consists often of entirely glossy black hairs. The black pelage extending halfway down the sides generally is finely punctate with minute white bands on the black hairs. The finely punctate condition rather commonly occurs all over the back. Rarely (four instances in 170), the black dorsum possesses a liberal sprinkling of white hairs among the black, and a few white hairs occur infrequently among the others. The dorsal pelage of the tails is banded black and white, and in aggregate this gives the impression of 10 or 12 bars across the dorsal surface of the tail.

The number of these 170 skins taken during each month of the year is: January, 16; February, 26; March, 39; April, 7; May, 19; June, 31; July, 0; August, 0; September, 3; October, 15; November, 7; and December, 4. No seasonal variation in pelage color is seen.

Three nestlings were preserved as skins among this series of 170 (February 18, March 24, and March 30) and from these, and the greater number of older immatures, it is evident that no regular ontogenetic change in the color pattern occurs. The black dorsal color of the nestlings is slightly less glossy and more brown than that of the adults.

In specimens progressively more distant from this center of color pattern strength of the subspecies, the dorsum becomes variably



and progressively paler until specimens which are entirely cream colored apparently predominate in peripheral populations (named ones of which are *tachardi*, *prachin*, and *rajasima*).

*Discussion.*—It should surprise no one that so many variations of this variable subspecies have been named in the early exploratory phase of knowledge of these squirrels. Quite possibly there are one or more populations particularly of wholly cream colored animals which may yet merit recognition as geographic subspecies distinct from the pied one. In the present effort to consolidate knowledge in a revision and to offer a meaningful picture of the geographic variation, the possibly oversimplified interpretation of the available evidence given above seems best.

In the south, specimens of *bocourti* have been collected near stations along the railroad three fourths of the way from Ayutthaya toward Nakhon Ratchasima: the localities Hin Lap, Muak Lek, Pak Chong, and Lat Bua Kao. From these places *bocourti* is very nearly a wholly cream-colored form, but some are faintly gray dorsally in the pattern characterizing the intensely black-and-white *bocourti* from the north. The specimen from Kao Lem [Khao Laem] is one with a notably dark dorsum and from a locality a little south from Pak Chong. Farther south near Krabin Buri the ranges of *bocourti* and *cinnamomeus* must come together, and among the five specimens of *cinnamomeus* we have examined from Sakeo in that vicinity one provides clear indications of intergradation with *bocourti* in possessing ventral pelage that is nearly white instead of red, and a whitish eye ring like the type of *floweri*.

On the west, the distribution of *bocourti* appears to be restricted by the Chao Phraya [river] across which it is opposed to *C. flavimanus siamensis* south of Ayutthaya. From Ayutthaya north to Nakhon Sawan *C. flavimanus siamensis* and *thai* and even *C. finlaysoni sinistralis* intergrade or cross with one another across the Chao Phraya from *bocourti*. Whether crossing the river naturally or with the aid of man, *bocourti* seems to have injected some genetic material into the population of *siamensis*, for the exceedingly atypical white venter of the type specimen seems best explained by such a cross. North of Nakhon Sawan, *bocourti* seems from the records to occupy the east side of the valley along the large fork of the Chao Phraya called the Mae Yom, which separates the fairly white *bocourti* from the fairly dark *sinistralis* as far north as Muang Phitchit. Beyond Phitchit *bocourti* is replaced on the east side of the river by *sinistralis* (Wroughton, 1908, p. 399). No specimens evidently intermediate between

these two forms have come to our attention. That intergradation between them may eventually be found seems suggested by the occurrence of the *sinistralis* character, a 30-40 mm. ring of white on the tail near its base, observed to be clearly but not fully expressed in two United States National Museum specimens of intensely pied *bocourti*, one each from Ban Muang Khai and Ban Seio.

On the north, both *sinistralis* and *bocourti* are replaced at Uttaradit and along the Mae Nam Nan by the wholly red form, *menamicus*. That all white *bocourti* do intergrade (or cross?) with the all red *menamicus* is to us clearly indicated by the intermediates (or hybrids) taken on Pahtoop Mountain above Nan and given the name *cockerelli*. A specimen taken by Herbert Deignan from Ban Khana some 30 miles farther up the Nan Valley near Pua, is quite like the description of *cockerelli* in having pale gray sides of mixed white and agouti hairs, sharply marked off venter, head and legs of cream color, but the broad stripe of Ferruginous from nape to base of tail along the mid-dorsum on the Pahtoop Mountain one is only pink in the Ban Khana specimen. Beyond the north end of the Nan Valley *bocourti* is probably replaced by *C. flavimanus zimmeensis*.

The Mekong Plain of eastern Thailand has hardly been penetrated by persons who collected mammals, and consequently the eastern extent of the range of *bocourti* for the most part remains uncertainly known. That it does extend out into the western edge of this plain is indicated by specimens taken at Ban Chum Phae by R. E. Elbel. That it does not occur all the way across to the eastern edge of the Mekong Plain is indicated by presence of another subspecies replacing it at Nakhon Ratchasima, and the few Thailand localities where tree squirrels have been collected farther east.

We realize that this *bocourti* is a very strongly marked (even though peripherally such a variable) squirrel. We realize that it may in fact *not* intergrade with *sinistralis*, *zimmeensis*, or *cinnamomeus*, and that further collecting in the zones of *bocourti* contact with *menamicus* and these other forms may possibly reveal that only hybridization is taking place, and that *bocourti* is specifically distinct from those forms. The evidence does not clearly indicate this now, however, and the more conservative course of retaining *bocourti* as a somewhat conglomerate subspecies seems the better justified.

To the east, *bocourti* probably does not progress to cream populations, but undoubtedly intergrades with the subspecies named below, for in the collection from Nakhon Ratchasima one of the four

(USNM No. 296516) is indistinguishable from *bocourti* and in the collection from Ban Sahng Kaw one of the seven (USNM No. 300061) is intermediate between *bocourti* and the following new subspecies, from eastern Thailand.

***Callosciurus finlaysoni boonsongi* new subspecies**

*Type*.—USNM No. 307801, an adult male taken on Phu Phan, a mountain in Sakon Nakhon District of Sakon Nakhon Province, eastern Thailand, June 14, 1954, by Robert E. Elbel and Boonsong Lekagul.

*Hypodigm*.—Thirty-two specimens from Phu Phan (USNM Nos. 307796 to 307827), the type locality; 12 specimens from Phu Do, a mountain in Nakae District, Nakon Phanom Province, eastern Thailand (USNM Nos. 307828 to 307839); 10 specimens from Phu Kho, another mountain in Nakae District, Nakon Phanom Province, eastern Thailand (USNM Nos. 307840 to 307849); seven specimens from Ban Sahng Kaw, Koek Pue District, Sakon Nakhon Province, eastern Thailand (USNM Nos. 300061 to 300066 and 300072); four specimens from Nakon Ratchasima, formerly known as Korat, on the southwestern corner of the Mekong plain, Thailand (USNM Nos. 296516 to 296519).

*Diagnosis*.—This new subspecies differs consistently from *bocourti* in that the black or dark pelage of the back covers the sides down to the margin of the ventral pelage. (In *bocourti* with dark backs the cream color of the venter encroaches well up onto the sides.)

*Pelage color*.—The color characteristics of this subspecies are complicated by occurrence in it of glossy black phase individuals (6 among the 65), creamy white phase individuals (3 among the 65), and red phase individuals (10 among the 65).

*Ordinary color*: These are almost wholly blackish squirrels, but vary much in the intensity of the black. Dorsal pelage is finely agouti and any color intermediate between black and a rather pale gray; always darker than the ventral pelage of the same individual. Ears regularly white-rimmed but occasionally all white, eyes sometimes ringed with white, but rostrum and feet rarely white or contrastingly lighter gray than the dorsum. Ventral pelage varying among individuals but generally gray and most often longitudinally bisected by a line of darker pelage. The tail is generally blackish, but subterminal white bands on the hairs occur in some individuals and become quite long posteriorly in still others.



*Reddish phase:* Those in reddish phase include one male from Phu Kho, two adult males from Phu Do, four males and two females from Phu Phan, and one adult male from Ban Sahng Kaw. Most of these (7) have all red pelage on the ears, head, and venter, a little red on the tail distally, and considerable red infusion of the dark dorsal pelage. Others (3) have red ears, venter, and tail tip but are so dark a red as to be nearly black.

*Black phase:* These possess entirely glossy black dorsal pelage excepting whitish ears and inconspicuous subterminal white bands (about 3 mm. long) on some hairs of the posterior half of the tail. The ventral pelage is blackish on the chin and throat, constituted by whitish-tipped, black hairs, and this extends posteriorly as a midventral wedge and then line bisecting the other ventral pelage. On each side of the blackish midventral line the ventral pelage is gray, and within it are axillary and inguinal paired spots of whitish pelage about 12 to 15 mm. in diameter. (These include adults of both sexes and are one female from Phu Kho, two males and two females from Phu Phan, and one female from Ban Sahng Kaw.)

*Cream phase:* This phase is exemplified by two females from Phu Do and one male from Phu Kho. They possess ventral pelage that is entirely cream color and dorsal pelage that has cream color pelage tips overlying dark gray bases which show through the cream color slightly.

One in cream phase is a parous female (USNM No. 307833) whose adulthood is further attested by complete ankylosis of the sagittal suture posterior to the nasals and the sutures about the interparietal, presence of all upper premolars fully erupted, and substantial wear on the cheek teeth. The other two in cream phase, however, are immatures (cheek teeth without wear; upper premolars deciduous; sagittal suture open; interparietal outlined by open sutures) taken July 16 and 25 and are evidently *molting to gray*. The ten other June and July immatures do not have quite all of the above indications of immaturity, and possess the black or gray dorsal pelage that is the ordinary condition or phase. Nothing appears to distinguish the pelage of these 10 from that of ordinary adults.

This subspecies is named for Dr. Boonsong Lekagul of Bangkok, Thailand, in recognition of his efforts to arouse in the Thai people an interest in increasing knowledge of the flora and fauna of Thailand through establishing, supporting, and using a national museum of natural history.



TABLE 9. Dimensions of Some Type Specimens of the Species *Callosciurus caniceps*

NAME	BODY			SKULL						
	Head & Body	Tail	Hind Foot	Total Length	Mas-toid Breadth	Length Nasal	Dia-stema	Length Palate	Length Bulla	Maxillary Tooth-row
<i>lancaensis</i> <sup>1</sup>	210	203	52	52.0	21.5	15.6	12.3	26.3	10.4	9.3
<i>telibius</i>	194	184	48	50.3	21.1	14.7	11.4	24.0	8.8	9.3
<i>adangensis</i> <sup>1</sup>	210	184	50	50.7	21.6	14.6	11.7	24.7	10.0	9.2
<i>terutaniensis</i>	240	220	51	54.3	22.8	16.5	13.0	26.5	10.0	9.1
<i>mohiens</i>	198	185	48	44.5	18.9	13.4	9.8	21.4	8.1	8.2
<i>mohilius</i>	192	174	45	47.4	20.0	14.0	10.8	22.3	8.9	8.6
<i>sullianus</i>	235	203	51	54.7	22.5	16.4	13.0	26.4	10.0	9.3
<i>mathaeus</i>	220	225	54	53.4	21.7	16.2	12.5	26.4	9.9	10.1
<i>lucas</i>	222	210	54	54.0	22.5	16.6	12.3	25.6	9.9	9.8
<i>altinsularis</i>	230	207	52	54.2	22.5	17.0	12.6	26.7	10.1	10.0
<i>samuiensis</i>	234	242	54	56.4	22.9	17.7	13.1	27.9	9.8	10.3
<i>nakanus</i>	220	200	51	54.1	21.6	16.3	13.1	26.3	10.0	9.3
<i>mapranis</i>	210	210	51	54.9	22.8	17.7	12.6	27.1	10.1	10.4
<i>panjius</i>	230	230	52	56.8	22.7	16.7	13.1	28.0	10.0	10.5
<i>panjoli</i>	230	220	55	55.8	23.2	17.4	12.6	27.9	10.4	10.5
<i>tacopius</i>	205	198	51	54.0	22.2	15.6	12.3	26.8	10.0	9.7
<i>pipidonis</i>	218	198	49	53.2	21.2	15.7	11.7	25.3	9.6	9.8
<i>hastilis</i>	235	197	54	56.0	23.3	16.9	12.7	26.5	10.6	9.9
<i>dometicus</i>	210	210	52	54.0	22.3	16.2	12.3	26.2	10.1	10.0
<i>bentincanus</i>	235	229	60	57.8	24.9	17.7	13.6	28.9	10.6	10.1
<i>inexpectatus</i>	194	180+	46	54.6	22.0	17.3	12.2	26.7	9.7	10.1
<i>helgei</i> <sup>1</sup>	185 <sup>2</sup>	219	52	50.2	20.9	14.6	10.6	24.6	10.0	9.9
<i>fuminalis</i>	234	...	56	57.6	23.3	17.4	13.4	26.5±	10.7	...

<sup>1</sup> The types of *lancaensis*, *adangensis*, and *helgei* are young adults.<sup>2</sup> Measured from nose to anus.

**Callosciurus caniceps** (Gray)

*Definition.*—*Callosciurus caniceps* is a species that includes subspecies *concolor* and *adangensis* that are extraterritorial, being entirely south of the Isthmus of Kra, and *bimaculatus*, *domelicus*, and *caniceps* in the Indochinese Subregion. See also the synonymy of each of these. The range of the species *caniceps* is shown in Figure 15.

*Diagnosis.*—Within the Indochinese Subregion this species is distinguished from all others by the combined characters of cool gray ventral pelage and a short, abruptly marked off, intensely black tip to the tail.

*Relationships to other species.*—The range of this tree squirrel is from Malaya north to the Salween River in Burma and to 19° 25' N. latitude (Doi Chieng Dao) in northern Thailand by our records. It is also distributed eastward across Thailand to the Mekong, but curiously we find no record of it in eastern Thailand south of about 14° north latitude (Ban Kabin Buri) nor any record from Cambodia.

Throughout its range species *caniceps* is sympatric either with species *flavimanus* or with *finlaysoni*. It is usually more of a lowland species than is *flavimanus* in the regions in which these two are sympatric, but where the two tend to occur together in generally low country *caniceps* is the larger animal. The species *finlaysoni* occurs with *caniceps* in the lowlands throughout central Thailand, and here also *caniceps* seems always to be the larger. See the accounts of species *phayrei* and *inornatus* for relationships of species *caniceps* to these.

Table 9 provides some body and skull dimensions of 23 of the type specimens of named forms that belong in this species.

**Callosciurus caniceps concolor** Blyth [Extraterritorial]

*Sciurus concolor* Blyth, 1855, Jour. Asiatic Soc. Bengal, **24**, p. 474.

*Sciurus lancavensis* Miller, 1903, Smithsonian Misc. Coll., **45**, p. 16.

*Callosciurus erubescens* Cabrera, 1917, Bol. Real. Soc. Espan. Hist. Nat., **17**, p. 518.

*Callosciurus concolor telibius* Thomas and Robinson, 1921, Ann. Mag. Nat. Hist. (ser. 9), **7**, p. 121.

*Types.*—*Sciurus concolor*, "From the vicinity of Malacca," Indian Museum (not seen); *erubescens*, MNCN No. 1.669 adult obtained in Selangor in May or June of 1900 by J. Waterstradt (not seen); *lancavensis*, USNM No. 104390, young male taken on Lankawi Is. December 1, 1899, by W. L. Abbott; *telibius*, BM No. 20.12.4.67, old male taken on Pulau Telibun, Trang, S.W. Siam, Jan. 2, 1917.

*Material examined*, from Malaya.—Straits Settlements [Malacca] (MCZ), one, (UMMZ), three, (BM), one; Kuala Lumpur (USNM), one, (BM), one; Ginting Bidai, 2300 feet, Selangor (BM), one; "Pahang River" (BM), one; Semangko Pass, Selangor-Pahang boundary (BM), one; "Panjum" *Kuala Lipis*, Pahang (BM), two; Telom River, 400 feet (BM), four; Gunong Ijau, 4700 feet, Perak (BM), one; Maxwell's Hill, 3600 feet, Perak (BM), one; Temengeh [also Temongoh and Tumangoh], 400 feet, upper Perak (BM), one; Ulu Selama [also Ulu Selamar], Perak (BM), five; Sungei Lebeh, Kelantan (NR), one; Kroh, 1100 feet, upper Perak (BM), nine; Gunong Gajah, Kedah (BM), one.

*Material examined*, from lower peninsular Thailand.—Bangnara [Bang Nara = Narathiwat] (USNM), 16, (MCZ), one, (AMNH), one, (CNHM), one, (UMMZ), one; Lankawi Island (BM), 12, (USNM), four; Bukit Patani (USNM), two; Patani (BM), two; Biserat, Jalor (BM), five; Ban Sai Kau [Nawngchik District] (BM), two; Singora [Songkhla] (USNM), two; "Pak Bayoon" (USNM), two; Nakon Sritamarat [Nakhon Si Thammarat] (USNM), eight, (ANSP), one, (CNHM), one; Pulo Telibun (BM), three.

*Original description*.—"Lower-parts dull ash-colour: the rest grizzled throughout with black and dull ruddy-ferruginous; the latter somewhat brighter on the middle of the back, croup, and upon the tail, which last is conspicuously ringed with black and dull ferruginous, and has a black tip mingled with hoary-white."

*Diagnosis*.—The above description fits quite well the material in the United States National Museum. The diagnostic characters are (1) the reddish suffusion of color occurring on the middorsum but not on the sides of the neck and body, (2) the actual absence of a sharply marked off, quite black tip of the tail, and (3) the cool silvery gray color of the venter.

*Discussion*.—It may be seen that material from the northwest edge of the range of this subspecies from Pulo Lankawi (named form *lancavensis*) and Pulo Telibun (named form *telibius*) and the northeast edge at Nakon Si Thammarat is intermediate between *concolor* and *bimaculatus* because it has the sharply marked-off, black tip of the tail, but it is listed here for convenience because it is otherwise like *concolor*. See Figure 15.

*Habits*.—Near Kuala Lumpur Harrison and Traub (1950, p. 339) tabulate data showing that *Callosciurus caniceps* was frequently taken in the forest, was observed in numbers in the town of Kuala

Lumpur, and was observed in abandoned clearings on the edges of country settlements, but that it was not found in the mountain forest about 5000 and 6000 feet of elevation on Gunong Brinchang near Cameron Highlands. On the other hand *Callosciurus flavimanus* was not taken in the lowland forest about Kuala Lumpur, nor in the town, nor in abandoned clearings but was observed in the above mountain forest. They also report of *caniceps*, "This squirrel is very common in secondary forest and in association with man. It builds nests in trees and feeds on fruit. Thirty-seven specimens were examined from the three forest sites." Later Harrison (1954, p. 161) reported further on its food, "Although this squirrel is abundant in waste land only a few shot specimens have been examined [for food]. The stomachs contained fruit and other vegetable matter, and one out of three contained a proportion of insects."

Robinson (in Bonhote, 1903, p. 21) comments from his own and Annandale's field notes: "This species is emphatically the village squirrel of the Patani States, and it is very exceptionable to find it otherwise than in the immediate proximity of dwellings. It is exceedingly abundant in the cocoanut groves and orchards, and commits great ravages among the fruit, being particularly destructive to the jack fruit or nangka (*Artocarpus integrifolia*). It is commonly seen on the trees in the early morning, up till about 9 a.m., and after about 4 p.m., and in the heat of the day remains hidden in the crowns of the palms, where it also forms nests similar to the *drey* of the British species. In South Perak, if it occurs, it must be very rare, and we never saw a specimen, but in the neighbourhood of Kuala Lumpur it, or a closely allied species, is fairly abundant. An entirely black variety was seen at Biserat on several occasions."

Audy and Harrison (1953, p. 10) comment "These . . . squirrels are abundant in the understory layer of forest and secondary forest, and come down to ground level freely. They range into scrub and cultivated country, and are well known in the gardens of town houses."

### ***Callosciurus caniceps adangensis* (Miller) [Extraterritorial]**

*Sciurus adangensis* Miller, 1903, Smithsonian Misc. Coll., 45, p. 17.

*Sciurus concolor terutavensis* Thomas and Wroughton, 1909, Ann. Mag. Nat. Hist. (ser. 8), 4, p. 535.

*Callosciurus moheius* Thomas and Robinson, 1921, Ann. Mag. Nat. Hist. (ser. 9), 7, p. 122.

*Callosciurus moheius mohillius* Thomas and Robinson, 1921, Ann. Mag. Nat. Hist. (ser. 9), 7, p. 122.



*Types*.—*Sciurus adangensis*, USNM No. 104389, a young male taken on Adang Island, Butang Islands, southwestern Thailand, on December 14, 1899, by W. L. Abbott; *terutavensis*, BM No. 9.11.1.54, an old male taken from Telok Udang, Teratau Island, Thailand, March 7, 1909, by H. C. Robinson; *moheius*, BM No. 20.12.4.72, a female taken on Pulau Mohea (northern half), 7° 14' N. latitude about 30 miles east of Siamese coast, February 2, 1919; *mohillius*, BM No. 20.12.4.75, a male taken from the southern half of Pulau Mohea February 3, 1919.

*Material examined*, all from islands off southwestern peninsular Thailand.—Pulo Teratau (BM), nine, (USNM), eight; Teratau Island [Pulo Teratau] (BM), nine; Pulo Adang, Butang Islands (USNM), two; northern part, Mohea Island (BM), three; southern part Mohea Island (BM), three.

*Discussion*.—This subspecies consists as presently known, of insular populations off the most southwestern coast of Thailand in the area of intergradation between *concolor* and *bimaculatus*. Their pelage characters include the sharply demarked tail tip of *bimaculatus* and the unornamented side pelage and venter of *concolor*. Although they vary somewhat among themselves in pelage color from one island to another, the diagnostic bright buffy midline of the ventral aspect of the tail links them together and distinguishes them from both *concolor* and *bimaculatus*.

### ***Callosciurus caniceps bimaculatus* (Temminck)**

*Sciurus bimaculatus* Temminck, 1853, *Esquisses Zoologiques sur la cote de Guiné*, p. 251.

*Sciurus epomophorus* Bonhote, 1901, *Ann. Mag. Nat. Hist.* (ser. 7), 7, p. 272.

*Sciurus davisoni* Bonhote, 1901, *Ann. Mag. Nat. Hist.* (ser. 7), 7, p. 273.

*Sciurus sullivanus* Miller, 1903, *Smithsonian Misc. Coll.*, 45, p. 17.

*Sciurus matthaeus* Miller, 1903, *Smithsonian Misc. Coll.*, 45, p. 19.

*Sciurus lucas* Miller, 1903, *Smithsonian Misc. Coll.*, 45, p. 20.

*Sciurus epomophorus milleri* Robinson and Wroughton, 1911, *Jour. Federated Malay States Mus.*, 4, p. 233.

*Sciurus concolor samuiensis* Robinson and Kloss, 1914, *Ann. Mag. Nat. Hist.* (ser. 8), 13, p. 226.

*Callosciurus epomophorus nakanus* Thomas and Robinson, 1921, *Ann. Mag. Nat. Hist.* (ser. 9), 7, p. 120.

*Callosciurus epomophorus mapravis* Thomas and Robinson, 1921, *Ann. Mag. Nat. Hist.* (ser. 9), 7, p. 120.

*Callosciurus epomophorus panjius* Thomas and Robinson, 1921, *Ann. Mag. Nat. Hist.* (ser. 9), 7, p. 119.

*Callosciurus epomophorus panjioli* Thomas and Robinson, 1921, Ann. Mag. Nat. Hist. (ser. 9), 7, p. 120.

*Callosciurus epomophorus tacopius* Thomas and Robinson, 1921, Ann. Mag. Nat. Hist. (ser. 9), 7, p. 121.

*Callosciurus epomophorus pipidonis* Thomas and Robinson, 1921, Ann. Mag. Nat. Hist. (ser. 9), 7, p. 121.

*Callosciurus epomophorus tabaudius* Thomas, 1922, Jour. Bombay Nat. Hist. Soc., 28, p. 1067.

*Callosciurus epomophorus hastilis* Thomas, 1923, Jour. Bombay Nat. Hist. Soc., 29, p. 377.

*Types*.—*Sciurus bimaculatus*, RNH No. 13363, an adult male from the peninsula of Malacca; *epomophorus*, BM No. 85.8.1.192, old female, from Salanga Island, Thailand, collected March 4, 1879, by J. Darling; *davisoni*, BM No. 85.8.1.187, young female, from Bankasun, Tenasserim, Burma, collected June 20, 1877, by W. Davison; *sullivanus*, USNM No. 104377, old female, from Sullivan Island, Burma, collected February 1, 1900, by W. L. Abbott; *matthaeus*, USNM No. 111920, adult female, from St. Matthew Island, Burma, collected December 11, 1900, by W. L. Abbott; *lucas*, USNM No. 104385, adult female, from St. Luke Island, Burma, collected January 20, 1900, by W. L. Abbott; *milleri*, BM No. 0.10.4.5, young male, from Trong, Thailand, collected February 20, 1896, by W. L. Abbott; *samuiensis*, BM No. 21.11.8.10, adult male, from Samui Island, Thailand, collected May 12, 1913, by H. C. Robinson and E. Seimund; *nakanus*, BM No. 20.12.4.43, old male, from Naka Island, Thailand, collected February 4, 1918, by H. C. Robinson and C. B. Kloss; *mapravis*, BM No. 20.12.4.51, adult female, from Maprau Island, Thailand, collected February 10, 1918, by H. C. Robinson and C. B. Kloss; *panjius*, BM No. 20.12.4.36, old male, from Panjang Island, Thailand, collected January 20, 1918, by H. C. Robinson and C. B. Kloss; *panjioli*, BM No. 20.12.4.41, adult male, from Panjang Anak Island, Thailand, collected January 29, 1918, by H. C. Robinson and C. B. Kloss; *tacopius*, BM No. 20.12.4.56, old male, from Takopah Island, Thailand, collected February 16, 1919, by H. C. Robinson and C. B. Kloss; *pipidonis*, BM No. 20.12.4.53, adult female from Pipidon Island, Thailand, collected February 3, 1919, by H. C. Robinson and C. B. Kloss; *tabaudius*, BM No. 28.8.21.2, an adult female taken on Tavoy Island, Mergui Archipelago, Burma, October 21, 1921, by C. Primrose; *hastilis*, BM No. 23.4.10.6, adult male, from Hastings Island, Burma, collected October 21, 1921, by C. Primrose.

*Material examined*, from mainland of peninsular Thailand.—Tha Lo [Ban Tha Lo], Bandon (USNM), three; Bandon [Amphoe Ban Don=Ban Makham Tia] (USNM), two; Trang (USNM), eight, (ANSP), one, (CNHM), one; Ban Ta [Tha] Yai (USNM), one; Kao [Khao] Luang (USNM), one, (CNHM), one; "Waterfall," Trang (USNM), two; Kao [Khao] Chong (BM), three, (USNM), one; Kao [Khao] Soi Dao (USNM), two; Poonga [Phangnga] (MCZ), one, (BM), two; Tang Pra [Laem Ao Kham], Takuatung (BM), four; Taptien [Tapting], Trang (BM), five; Chong, Trong (BM), three; Gap Patalong, Trang (BM), one; "Lem Ma," Trang (BM), three; Nam Chuh, Pak Chan (BM), one; "Renong River" [Ranong] (BM), two; Klong [Khlung] Wang Hip, Tung Sawng [Thung Song] (BM), one; Mamoh, Pakchan (BM), two; Torsan [Ban Tha San], Chuntawn [M. Chum Pon] (BM), one; Nong Kok, Grabi [Ban Nong Kok, Krabi] (BM), one.

*Material examined*, from Siamese islands west of peninsula.—Tongka [Koh Phuket] (BM), eight; Telok Palas [Ban Ao To Nong, Koh Phuket] (BM), two; DeLisle, or Piam, Island (BM), four; "Pasir Raja Is." (BM), six; Pipidon Island (BM), two; Maprau Island (BM), four; Panjang Island (BM), two; Panjang Anak [Island] (BM), three; Naka Island (BM), three; Takopah Island (BM), three; Pulo Sarik, Tongka [Ko Sire, near Ko Phuket] (BM), five.

*Material examined*, from Siamese islands east of peninsula.—Koh Samui [Ko Samui] (USNM), four.

*Material examined*, from Tenasserim mainland, Burma.—Bok Pyin (USNM), one; Maliwun (USNM), two; Victoria Point (USNM), three, (BM), one; Sungei Balik (USNM), one; Tanjong Badak (USNM), two; Champang (USNM), one; Boyce's Point (USNM), one; Bankasoon (BM), 14 topotypes; Taroar [Tagoot], Malay Peninsula (BM), one; "Kussoom," N.W. peninsula, south of Tenasserim (BM), one; Tenasserim Town (BM), one.

*Material examined*, from Mergui Archipelago, Burma.—St. Matthew's Island (USNM), four; St. Luke's Island (USNM), one; Hastings Island (BM), three; Sullivan Island (BM), two, (USNM), five; Clara Island (USNM), one; James Island (USNM), three; Tavoy Island (BM), two; King Island (BM), six; "Nathay Mine" (BM), six; Kisseraing Island, 100 feet (BM), three; "Sir John Malcolm Island," 100 feet (BM), two.

*Original description*.—Temminck's species *bimaculatus* clearly belongs here, for his description of it nicely provides the pelage characters diagnostic for this subspecies: "The upper parts of the head,

neck, all the back and the tail as far as the tip bear a . . . pelage regularly ringed with ashy and black . . . the sides of the neck, the upper part of the legs and flanks are of the red of rust; the lower parts are of a whitish gray."

Another very early specimen erroneously referred by Horsfield (1824, no. 7, p. 8) to *Sciurus affinis* Raffles, 1822, is sometimes (e.g., Ellerman, 1940, p. 355) treated as if it were the type of another *affinis*, even though *Sciurus affinis* Raffles is at the same time recognized as valid for a species of *Ratufa*. The description by Horsfield, and his specimen do clearly belong to what is now another genus, *Callosciurus*, and in the present species and subspecies, but *Sciurus affinis* Horsfield, 1824, is a primary homonym of *Sciurus affinis* Raffles, 1822, and is permanently rejected (Mayr, Linsley and Usinger, 1953, p. 312).

*Diagnosis.*—The present subspecies is characterized by being gray where *concolor* is reddish (i.e., on the middorsum) and reddish on the sides where *concolor* is gray. There is considerable variation in intensity of both the gray and the red, and some of it is geographic, but these differences adequately distinguish the present subspecies from the localities presently indicated. *Callosciurus caniceps bimaculatus* also has a sharply black-tipped tail, and as mentioned above, this also occurs on material which is geographically intergrade between *concolor* and *bimaculatus*. The type specimen of *bimaculatus* does also have a white tip distal to the black tip, but in the opinion of the one of us (Tate) who examined it, the white tip is an individual aberration.

The reddish infusion of the color on the sides which characterizes *bimaculatus* extends over the side of the neck posterior to the ear and along the side of the body, posteriorly extending ventrally onto the groin. It may or may not be continuous from the neck across the shoulder to the side of the body and from the side onto the thigh. In areas where the red side color is most intense, it tends to be so continuous; in areas where the red color pales, the side of the neck and groin retain the most color almost as a large spot in each place. Koh Phuket is a focal geographic area for intensification of the red.

*Pelage color.*—The venter is generally gray with an overlay of whitish hair tips, and a darker gray midline of agouti pelage, but in areas where the sides are intensely red, there may be a general suffusion of reddish invading the ventral pelage.

*Habits.*—One highly qualified observer collecting this squirrel in most southern, peninsular Burma comments: "Very plentiful every-



where, both around habitations and in the thickest forest. A thick-set rather clumsy looking squirrel. Wherever there are plantations this squirrel destroys large numbers of cocoanuts, by drilling a circular hole in the side and extracting the contents. Weight. 10-14 ozs." (G. C. Shortridge in Wroughton, 1915b, p. 713.)

*Discussion.*—In the collections of the named forms of the mainland north of subspecies *concolor* that are available in the United States National Museum, we laid out 16 specimens of "*davisoni*" from the Isthmus of Kra near the tenth parallel of latitude north (see Figure 15), and 14 specimens of "*milleri*" from Trong, represented in Figure 15 by the southernmost all-black dots. We could find no consistent difference between these either in color or size, both lots proving quite variable and the number of individuals showing intermediacy in any particular character often exceeding the number that show a discrete difference.

Although St. Matthew's Island and Sullivan Island of the Mergui Archipelago are both outside the nine meter depth line (Fourth Survey of India, U. S. Army Map Service, 1944, sheet N. C. 47) the named forms from them, *matthaeus* and *sullivanus*, are indistinguishable from each other by comparison of the original hypodigms (5 and 6 specimens respectively) and are indistinguishable from the series of thirty specimens of *bimaculatus* from the adjacent mainland. St. Luke's Island and Hastings Island are satellite islands of St. Matthew's Island, each less than a mile from it and connected to it by shallows less than nine meters deep. The original hypodigm of two specimens of the named form from St. Luke's I., *lucas*, are distinguishably darker than all of the mainland sample of *bimaculatus*, but not the St. Matthew's I. sample. In lumping the Hastings I. form, *hastilis*, with *bimaculatus* (= *davisoni*), we follow Ellerman and Morrison-Scott (1951, p. 486).

### ***Callosciurus caniceps casensis* (Miller) [Extraterritorial]**

*Sciurus casensis* Miller, 1903, Smithsonian Misc. Coll., 45, p. 19.

*Type.*—USNM No. 104370, a young female taken on Chance Island, Thailand, December 28, 1899, by W. L. Abbott.

*Material examined.*—Chance Island, off west coast of peninsular Thailand (USNM), four.

The original hypodigm of five specimens, all we have seen, vary little among themselves. They have the ventral side of the tail strikingly paler than those of any specimens of geographically nearby

forms of *caniceps* and grayer than the somewhat yellowish ones of *altinsularis*, which are from High Island 110 miles to the north.

### ***Callosciurus caniceps altinsularis* (Miller)**

*Sciurus altinsularis* Miller, 1903, Smithsonian Misc. Coll., **45**, p. 21.

*Type*.—USNM No. 111975, an old female taken on High Island, Burma, December 31, 1900, by W. L. Abbott.

*Material examined*.—High Island, Mergui Archipelago, Burma (USNM), four.

The four specimens and the type laid out together, vary hardly at all among themselves, and do not differ ventrally from several of the *bimaculatus* in the United States National Museum, but the dorsal pelage as a whole is slightly but distinctly paler than any of the *bimaculatus* and paler than any of the nearby insular forms except *casensis* (which, however, is much more brilliantly colored).

### ***Callosciurus caniceps fallax* (Robinson and Kloss)**

*Sciurus concolor fallax* Robinson and Kloss, 1914, Ann. Mag. Nat. Hist. (ser. 8), **13**, p. 225.

*Type*.—BM No. 21.11.8.9, an adult male taken on Pennan (or Pangnan) Island, Thailand, 9° 45' N. latitude off east coast, on May 30, 1913.

*Material examined*.—Koh Pangan, Thailand (USNM), four.

The material examined is consistent within the series and distinguishable from *bimaculatus* by having paler tails (quite like those of *casensis*). It differs from *casensis* by quite dull pelage, the ruddiness of the sides being barely noticeable, and differs from *altinsularis* by much darker pelage on both dorsum and venter, and very much greater size.

It seems a bit odd that the principal distinguishing character of *fallax* should be one shared only with two insular forms on the far side of the Malay peninsula, *casensis* 140 miles west and very slightly south, and *altinsularis* about 140 miles northwest.

### ***Callosciurus caniceps domelicus* (Miller)**

*Sciurus domelicus* Miller, 1903, Smithsonian Misc. Coll., **45**, p. 18.

*Sciurus bentincanus* Miller, 1903, Smithsonian Misc. Coll., **45**, p. 19.

*Types*.—*Sciurus domelicus*, USNM No. 104381, an adult female taken on Domel Island, Mergui Archipelago, February 24, 1900, by

W. L. Abbott; *bentinckanus*, USNM No. 104383, an adult female taken on Bentinck Island, Mergui Archipelago, March 11, 1900, by W. L. Abbott.

*Material examined*.—Domel Island (USNM), four; Bentinck's Island (USNM), three; Kisseriang Island (USNM), one.

The sample of five specimens from Domel Island representing this form is a darker gray ventrally than any of the material of *bimaculatus* examined (by Moore). Since the Bentinck's Island material is also rather dark dorsally and intensely red laterally like the material from Domel Island, and is separated geographically by Domel Island from the mainland range of *bimaculatus*, it is here included in the subspecies *domelicus*. The subspecies *domelicus* also occurs on Kisseriang Island which lies between Domel Island and the mainland.

### **Callosciurus caniceps caniceps (Gray)**

*Sciurus caniceps* Gray, 1842, Ann. Mag. Nat. Hist. (ser. 1), 10, p. 263.

*Sciurus chrysonotus* Blyth, 1847, Jour. Asiatic Soc. Bengal, 16, p. 873.

*Sciurus epomophorus inexpectatus* Kloss, 1916, Jour. Nat. Hist. Soc. Siam, 2, p. 178.

*Sciurus helgei* Gyldenstolpe, 1917, Kungl. Svensk. Vet. Handl., 57, no. 2, p. 34.

*Sciurus caniceps helvus* Shamel, 1930, Jour. Mammal., 11, no. 1, p. 72.

*Sciurus epomophorus fluminalis* Robinson and Wroughton, 1911, Jour. Federated Malay States Mus., 4, nos. 3 and 4, p. 233.

*Types*.—*Sciurus caniceps*, BM No. 213a (41.1817), an adult male from Tenasserim; *chrysonotus* (not seen), from Tenasserim Valley; *inexpectatus*, USNM No. 221557, a young female (deciduous upper fourth premolar still present) from Koh Lak, Pran, latitude 11° 45' N., southwest Siam, collected November 15, 1916 by C. B. Kloss; *helgei*, NR No. 71, a young male from Koh Lak, Siam, collected November 29, 1914, by N. Gyldenstolpe; *fluminalis*, BM No. 7.11.13.17, an adult male taken at the Meping Rapids, Siam, August 8, 1907, by T. H. Lyle.

*Material examined*, all from Koh Tau, Thailand (USNM), 12.

*Material examined*, from the mainland of Thailand.—Khao Luang (ANSP), five, (CNHM), one; Hat Sanuk, near Koh Lak, Rajburi (BM), six; Pran [Prachuap Khiri Khan] (USNM), five; Koh Lak [Prachuap Khiri Khan] (CNHM), one, (USNM), five, (NR), one, (BM), eight; Sam Roi Gop [Sathani Sam Roi Yot] (USNM), four; Kwe Koi [Mae nam Khwae Noi] (USNM), one; Muang Kan Buri

[Kanchanaburi] (CNHM), one, (USNM), two; Ban Pong, Rajburi (USNM), one; "Nong Mong, Muang Krabin" [*Ban Kabin Buri*] (USNM), two; "Lam Ton Lang, Krabin" [*Ban Kabin Buri*] (USNM), two; Krabin [*Ban Kabin Buri*] (BM), three; Kao Lem [Khao Laem] (USNM), two; Pak Jong [Ban Pak Chong] (AMNH), four, (CNHM), one, (USNM), two; "Lam Klong Lang, Pak Chong" [*Ban Pak Chong*] (USNM), one; Muek Lek [Ban Muak Lek] (CNHM), one; Lat Bua Kao [Ban Lat Bua Khao] (USNM), one; Siken, near Korat [Ban Si Khiu] (USNM), one; Chainat [Muang Chainat] (BM), one; Pak-nampo [Ban Pak Nam Pho] (MCZ), one, (BM), two; Nakon Sawan [Nakhon Sawan] (BM), two; Bung Borapet [Boraphet] (USNM), one; Um Pan [Ban Um Phang=Ban Le Kathe] (AMNH), two, (BM), two; Longlung [near Ban Nong Pla Lai] (BM), one; Wung Pratart Farm, Kampengpet Prov. (CNHM), three; Klong Klung [Ban Khlong Khlung] (CNHM), five; Kampengpet [Changwat Kamphaeng Phet] (AMNH), one, (CNHM), two, (BM), one; Sawan Kaloki [Sawankhalok=Ban Wang Mai Khon] (BM), three; Pak Koh (NR), two; Ban Hue Hom (NR), one; Mee Tan [Ban Mae Tan Nua] (BM), two; Mt. Chieng Dao (USNM), two, (AMNH), three; "Watpa" (ANSP), one; "Ubol Chanumon" (ANSP), one; "Nong Dom" (UMMZ), three; "Me Ping River" (AMNH), one; (BM), four; "Ban Kon" (NR), one; "Kao Phlyng" (NR), one; Phan Mt., Sakon Nakhon (USNM), two; Lomlo Mt., Ban Maeo (USNM), 17; "Phak Khinak Mt.," *Dan Sai* (USNM), one; "Nam Lang Mt.," *Ban Khok* (USNM), one; Kowjeen, Pak Tho, Rajburi (USNM), two; "Pukongchai," Korat (USNM), one; Hin Laem, Tra Khanun, Kanchanaburi (USNM), 16; Ban Klua Klang, Prachuap Kiri Khan (USNM), three; "Ban Sop Luak," *Chiang Saen Kao*, Chiang Rai (USNM), one; "Mushi Tar Shang," Korat (USNM), one; "Ban Hua Thanon," *Klong Klung* (USNM), six; Kowkat, Paknampho (USNM), 16; Kowkob, Paknampho (USNM), two; "Moung Wat Sy Tie," *Nakorn Sawan* (USNM), one; "Sretahn, Wung Sapueng," *Loei* (USNM), one.

*Material examined*, from Burma.—Tavoy (BM), two; "Shan Mepa," *Amherst* (BM), one; "Tikotaw" *Amherst* (BM), one; Lakya (AMNH), two; Kawlichuang (AMNH), one; Lampha (AMNH), one, (BM), three; Moulmein (BM), three; Kawkareik (AMNH), one, (BM), one; Myawadi (BM), one; "Lothorgu," *Myawadi* (BM), one; "Thoungyin River, 1500 feet" (BM), three; "Thoungyin above Myawadi" (BM), three.



*Original description.*—Gray's type description of *caniceps* is very bare: "Pale gray, grised; back yellowish, beneath paler gray; tail long, gray, black varied, ringed, hair with three broad black bands."

*Pelage color.*—Dorsal pelage color of American Museum Tenasserim material is about Orange Rufus (II) and that of Doi Chiang Dao about Ochraceous Orange (XIV). Ventral pelage color is an agouti of about Deep Gull Gray (LIII) in this Tenasserim and middle Siam material, and about Light Gull Gray in the northernmost. Every American Museum specimen has a darker agouti, longitudinal midventral stripe about four to six millimeters wide. The throat, chin and under sides of legs are like the general color of the venter. The tail hairs have five black bands besides the black tips. The tips of the tails are all abruptly black. Dorsally the tail and all legs are agouti of about Mouse Gray (LI). The dorsal pelage of the feet, snout and ear tips is notably lighter and corresponds closely to the ventral pelage color. The bright orange color covers the back and sides, fading into agouti gray as it approaches the venter, on the crown, and on the proximal one-tenth of the tail.

*Habits.*—Gyldenstolpe (1914, p. 11) remarks interestingly, "In Siam this species was only common in the bamboo-forests in the North and seemed to live in rather high altitudes. In the bamboo-forests on the Korat plateau in Eastern Siam it was never observed."

*Discussion.*—Although the named form *inexpectatus* is distinguishable when one compares series of study specimens in a museum, it seems to occupy but a small geographic area between the ranges of subspecies *bimaculatus* and subspecies *caniceps*, the rainshadow area of peninsular Thailand north of about 11° North latitude. Since its observed characters in the material examined are but transitional between those of *bimaculatus* and *caniceps*, it is here regarded as intermediate between those two subspecies and not fully belonging to either, but for convenience the records of it are lumped with *caniceps*. The named form *helvus* from Koh Tao is rather distinct, but the real interest which attaches to the Koh Tao material is that it shows relationship as close to *caniceps* as to the geographically nearer *bimaculatus*, and like the sample of "*inexpectatus*" is actually intermediate. Inclusion of it with subspecies *caniceps* emphasizes the interest which attaches to its close relationship to *caniceps* across a much greater water gap. It is interesting, too, that the sample from Koh Phangan *fallax*, which lies between the Koh Tao population and the *bimaculatus* of the nearest mainland is good *bimaculatus*, but shares with the Koh Tao sample a character which differs from mainland *bimaculatus* (pale underside of tail).

It certainly seems worth mentioning here that in the American Museum of Natural History material the roughly topotypical *caniceps* specimens from the heavy rainfall area of upper Tenasserim are not darker colored than ones from the much drier, rainshadow area of Siam almost directly east (localities Kawkereik, Lampha, Kawlichauung, and Lakya in Burma, versus Um Pang, Me Ping, and Kam-pengpet, Siam). The northernmost material that we have seen for *caniceps*, from Doi Chieng Dao, is notably lighter in both dorsal and ventral pelage, and is also slightly larger than this more southern American Museum material. If these differences could be shown to be consistent over a considerable geographic area, the name *fluminialis* Robinson and Wroughton would be available for the subspecies.

The orange-colored dorsal pelage of *Callosciurus c. caniceps* has been reported to change to agouti gray color seasonally. The following records from examination of museum specimens in London (by Tate) and Chicago, Boston, and New York (by Moore) provide some evidence of such seasonal change: January, 12 orange, no gray; February, four orange, no gray; March, 12 orange, one changing, one gray; April, one orange, two changing, no gray; May, no data; June, one orange, three changing, nine gray; July, no orange, one changing, two gray; August, no data; September, no orange, one gray; October, one orange, two changing, no gray; November, three orange, one gray; December, two orange, one changing, no gray. It thus appears that in the November through April or May dry season the pelage is more often orange, but during the June through October season of rains, the dorsal pelage is more often gray.

Some of the specimens that we have recorded above as "changing" may possibly be only intermediate in some other sense. However, one (CNHM No. 47332) in April was definitely molting the orange and replacing it with gray, and one December specimen (AMNH No. 54692) seems to be changing from gray to orange without showing a molt line, by the simultaneous appearance of orange in large patches throughout the length of the back. In this latter specimen the guard hairs of the remaining patches of agouti gray pelage seem under magnification quite as fresh as those of the incipiently orange blotches. Furthermore, the guard hairs of the incipiently orange blotches are agouti and only warmly colored on the two light bands (more deeply colored on the proximal one), and more of the orange color seems attributable to the thinner under hairs. However, in a fully orange specimen of January 19th (AMNH No. 54707)

TABLE 10. Dimensions of Some Type Specimens of the Species *Callosciurus phayrei* and *C. inornatus*.

NAME	BODY			SKULL						
	Head & Body	Tail	Hind Foot	Total Length	Mas-toid Breadth	Length Nasal	Dia-stema	Length Palate	Length Bulla	Maxillary Tooth-row
<i>phayrei</i> <sup>1</sup>	190 ±	160 ±	50	....	22 ±	16.2	12.1	25.4	10.0	9.5
<i>phayrei</i>	220 ±	210 ±	54	54.4	21.9	16.8	12.9	26.2	10.0	10.3
<i>blanfordi</i> <sup>1</sup>	235 ±	180 ±	55	51.6	21.9	16.0	11.2	24.7	10.2	9.8
<i>blanfordi</i>	195 ±	120 ±	46	46.0	....	13.7	10.6	22.8	8.8	7.7
<i>inornatus</i>	225 ±	210 ±	47	....	20.8	15.8	11.2	23.9	9.9	9.6
<i>imitator</i>	218	195	49	52.2	22.1	17.3	11.0	25.2	9.4	9.7

<sup>1</sup> *C. phayrei* and *C. blanfordi* are both represented by two cotypes with skulls. The first of *blanfordi* is recorded by us as a juvenile and the second as an old male, but their relative dimensions suggest that the reverse is true.

from nearby, the guard hairs are not agouti but are entirely orange excepting the thin, short, black tip and a short paler base, and there seems to be very little pelage wear (breakage of these guard hairs). In a fully orange March 3rd specimen, the pelage is as in the preceding specimen but shows wear (has the tips of a good many guard hairs broken off). These few superficial observations suggest that at the end of the rainy season, orange color may replace the black and white bands on the agouti guard hairs rather than orange guard hairs replacing black and white banded guard hairs by molt. Thus it may be that this tropical tree squirrel molts but once annually while accomplishing change in color twice a year, although it seems well established that the well-studied north temperate tree squirrels *Tamiasciurus hudsonicus*, *Sciurus vulgaris*, and *Sciurus carolinensis* are known to molt twice a year (each spring and fall).

### **Callosciurus phayrei** (Blyth)

*Sciurus phayrei* Blyth, 1855, Jour. Asiatic Soc. Bengal, 24, p. 472.

*Sciurus blanfordi* Blyth, 1862, Jour. Asiatic Soc. Bengal, 31, p. 333.

*Callosciurus griseimanus heinrichi* Tate, 1954, American Mus. Novitates, no. 1676, p. 1.

*Types*.—*Sciurus phayrei*, BM No. 62.7.16.7, an adult male taken at Martaban, Burma, by Major Phayre; *blanfordi* BM No. 63.5.-9.9, an immature taken at Mt. Ava about 20 mi. S.W. of Mandalay; *heinrichi* AMNH No. 163466, an adult female taken at Maymyo, Mandalay, Burma, at 800 meters elevation on December 6, 1937, by Gerd Heinrich.

*Material examined*, all from Burma, south to north.—Martaban (BM), one cotype; Thatone [Thaton] (BM), three; Pahpoon [Papun] northern Tenasserim (BM), two; "Bantam, Kiu Pang Valley," Salwin Distr. (USNM), one; five miles east of Toungoo, 100 feet (CNHM), two; 40 miles north of Toungoo, 500 feet (BM), four; "Ta-hó, Kareni" (USNM), one; Mt. Ava (BM), one cotype; seven miles southeast of Mandalay (USNM), one; Maymyo, 800 meters (AMNH), six; Gokteik, 2100 feet (BM), three; Kokkoaing, 40 miles N.N.E. of Mandalay, 800 feet (BM), one; Ngapyiniun, 250 feet, opposite Kyaukmyaung, on Irrawaddy R. (MNH), one, (BM), six; Pyaunggaung, 2800 feet (BM), three; Hsipaw, 1350 feet (BM), two; Se'en, 1400 feet (BM), five, (CNHM), two.

Table 10 provides some body and skull dimensions of some of the type specimens of named forms that belong in species *Callosciurus phayrei*.



*Definition.*—The species *phayrei* is accepted here as monotypic and is confined to the region between the valley of the Sittang and upper Irrawaddy rivers and Salween River as shown in Figure 15.

*Diagnosis.*—The species *phayrei* has the following distinctive color characters of the pelage. (1) The rostrum, ears, crown, and side of neck are agouti gray like the dorsum. (2) The contrasting color of the manus stops abruptly at the wrist. (3) The tail is tipped briefly and rather abruptly with black. (4) The ventral pelage varies from a rich orange to a very pale orange but is never red or gray. (5) All four feet are yellowish buff to pale orange. (6) Long, yellow bases of the ventral tail hairs provide a rich yellow midstripe 12 to 15 mm. wide along the under side of the tail. (7) There is usually at least a faint blackish band 20 mm. wide along (and within) the lateral margins of the ventral pelage. (8) There are five blackish bands on the fully grown out tail hairs.

The above characteristics distinguish species *phayrei* from the subspecies of other species that are geographically closest to *phayrei*, as follows: *C. erythraeus sladeni* by 1, 2, 3, 4, 5, 6, and 7; *C. flavimanus shanicus* by 1, 4, 5, 6, and 7; *C. flavimanus zimmeensis* by 1, 2, 4, 5, and 7; *C. ferrugineus* by 1, 2, 3, 4, 5, 6, 7, and 8; *C. c. caniceps* by 4, 5, 6, and 7; *C. pygerythrus janetta* by 1, 2, 5, 7, and 8.

*Relationships to other species.*—This species appears to inhabit the rain forest vegetation area from Martaban at the mouth of the Salween River north to about Toungoo, and to occupy the strip of tropical deciduous forest along the escarpment of the Shan Highlands from about Toungoo north to at least fifty miles north of Mandalay (according to the map of vegetation zones of Burma by de Terra (1944, p. 80). On ecological grounds it seems very likely that the range of *phayrei* would extend up the long corridor of rain forest of the Salween River valley. Whether it also occurs throughout the Shan Highlands seems more doubtful for the Maymyo, Gokteik, Pyaungaung, and Se'en localities seem to lie along the southeastern margin of an eastward jutting of the tropical deciduous forest into the "mixed forest with grassland" of the Shan Highlands (de Terra, 1944, p. 80), and may not represent habitat typical of the Shan Highlands.

*Relationships between C. phayrei and C. erythraeus sladeni.*—While our record of the distribution of *phayrei* from material examined leaves large gaps where its occurrence remains to be ascertained, its range seems to be confined between two rivers, on the south and east by the Salween and on the west by the Irra-

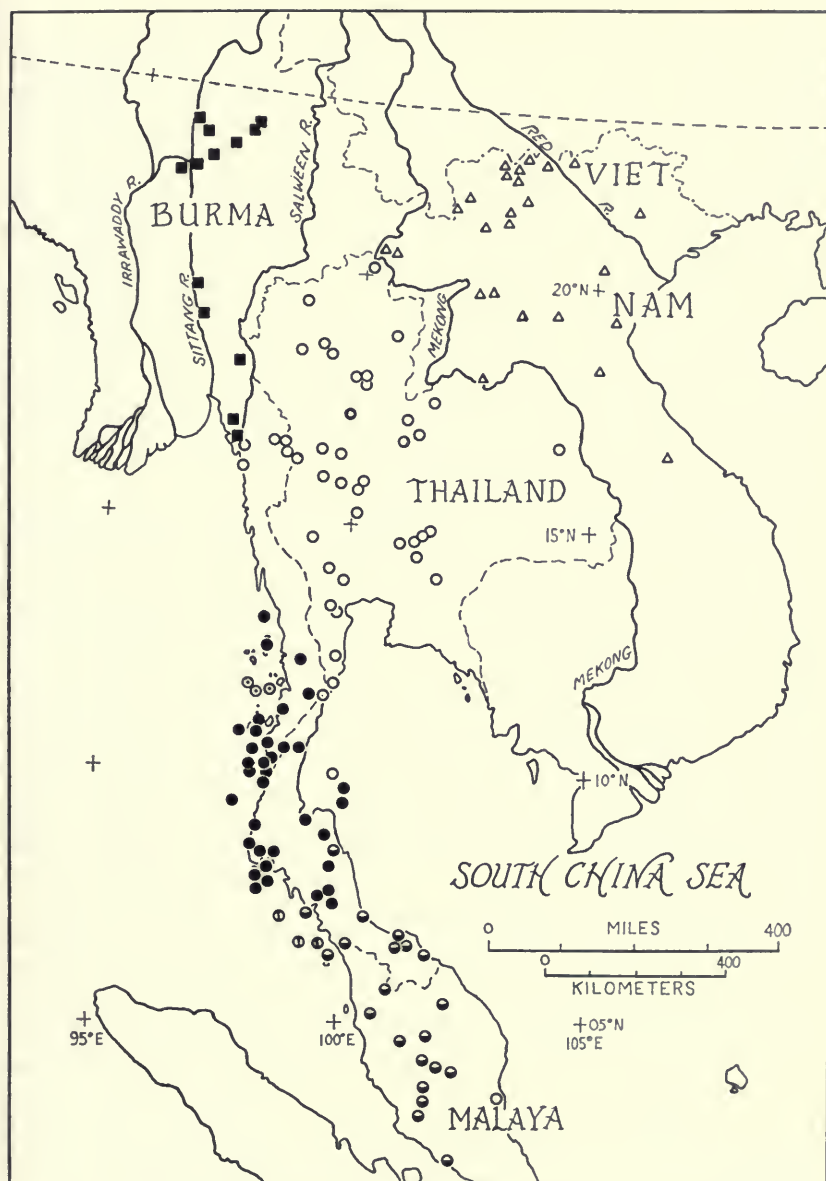


FIG. 15. Geographic distribution of three species, as determined from material examined: the Tenasserim squirrel, *Callosciurus caniceps*, circular symbols; the Shan Highlands squirrel, *Callosciurus phayrei*, black squares; and the Laotian squirrel, *Callosciurus inornatus*, triangles. Subspecies of *caniceps*: half black [extraterritorial], *concolor*; vertically divided [extraterritorial], *adangensis*; all black, *bimaculatus*; dotted circles, *domelicus*; and open circles, *caniceps*.

waddy. Across the upper Irrawaddy *phayrei* seems to be ecologically replaced by *sladeni* as the tree squirrel of medium size in the forests in the broad fertile valleys and relatively low hills of this intertropical area of Burma. See map figs. 13 and 15.

Besides occupying what is apparently the same ecological niche on opposite sides of the Irrawaddy River *phayrei* and *sladeni* share a number of characteristics of the pelage: (1) The dorsal pelage of all four feet is colored like the venter. (2) The dorsal pelage of the body and proximal part of the tail are an agouti gray with three light bands on many of the guard hairs of the middorsum and with five black bands on the hairs of the tail at its midlength. (3) The tail is not agouti at its tip. (4) The ventral pelage is orange-red or orange but never divided down the midline by an agouti stripe. (5) The ears are the same color as the dorsum.

The pelage characters which distinguish *phayrei* and *sladeni* are: (1) The specimens of *sladeni* almost invariably have the rostrum, and sometimes the crown back as far as the ears, colored like the feet; whereas the rostrum and crown of *phayrei* are as agouti gray as its back. (2) The color of the manus in *sladeni* extends up onto the forearm, meeting the agouti gray abruptly for half the forearm's length; whereas in *phayrei* the manus color terminates abruptly at the wrist. (3) In *sladeni* the tail has a rather long, reddish tip, but in *phayrei* the tail tip is short, fairly abrupt, and black. These three characters, in the absence of any known area of intergradation, suggest something more than subspecific difference between the two. Even though the evidence is excellent that the subspecies *sladeni* and *haringtoni* are conspecific, and although the pelage difference between *sladeni* and *haringtoni* appears to exceed that between *sladeni* and *phayrei*, the latter two are not known to intergrade: their differences are great enough that they probably would not interbreed if brought together naturally, for example, by a shift of the course of the Irrawaddy and elimination of the old channel. (Intergradation between *sladeni* and *haringtoni* is apparently accomplished only through another subspecies and interbreeding might not occur at all between individuals of these two forms themselves if they could be brought together under natural conditions.)

The Sittang Valley separates the range of *C. phayrei* from that of *C. ferrugineus* to a great extent, although the specimen of *phayrei* from Ava shows that *phayrei* has crossed the valley a short distance eastward and a specimen each from Gokteik and Lawksawk indicate that *ferrugineus* has crossed the valley westward. It is assumed

that this condition of limited or incipient sympatry has come about entirely since the capture of the headwaters of the "Irta-Sittang" by the "Chindwin-waddy" (*i.e.*, the removal of the river barrier from the Sittang Valley). Their difference in pelage color is virtually total, *ferrugineus* being an all red species with some blackening on the feet and tail. This fact and those of sympatry with no evidence of intergradation demonstrates that *phayrei* and *ferrugineus* are separate species.

*Similarities between C. caniceps caniceps and species phayrei.*—From the material examined, it appears that the subspecies *caniceps* extends northwestward in typical form to the vicinity of the Salween River and stops abruptly there; and immediately on the other side of the Salween River the species *phayrei* apparently replaces *caniceps* ecologically. The lack of intergradation between these two forms and the niceness of their separation by the existing geographic barrier of the river are such that no previous student has regarded them as conspecific. Nevertheless, the number of evidences of close relationship is great: (1) The back, sides and dorsum of the tail of *phayrei* are colored like those of gray phase *caniceps*. (2) The tail tip in *phayrei* is black like that of *caniceps*. (3) The head, ears, and rostrum of *phayrei* are gray as in gray phase *caniceps*. (4) All four feet are strikingly light in both forms, lighter than their respective ventral pelage. (5) The tail hairs have five black bands additional to black tips in both forms, and the guard hairs of the dorsum have two white or very pale buffy bands in *phayrei* as in the gray phase of *caniceps*. (6) The frontal projects forward as a thin process between the nasal and the premaxillary on each side, often to a distance equaling least width of nasal in many subspecies of *Callosciurus*; but it does not do this in *caniceps* or in the material representing *phayrei* in the American Museum of Natural History. (7) Subspecies *caniceps*, unlike most mainland forms of large *Callosciurus*, is strongly proödont, and the seven Maymyo specimens of *phayrei* are at least somewhat proödont.

*Distinctions between species phayrei and C. caniceps caniceps.*—(1) The ventral pelage is Light Ochraceous Buff to Ochraceous Buff (in the Maymyo series) even approaching Ochraceous Orange on the underside of the hind legs, compared to the whitish over pale gray of *caniceps*, and lacks any vestige of the midventral agouti stripe of *caniceps*. (2) All four feet are dorsally Light Ochraceous Buff in *phayrei* (Maymyo series) but about Pale Gull Gray (LIII) in *caniceps* (Mt. Chieng Dao series). (3) The ventral aspect of the tail of



*phayrei* reveals long, yellow bases of ventral tail hairs so that the tail has a Warm Buff midstripe 12 to 15 mm. wide beneath but is cool gray dorsally. In *caniceps* some faint yellow color shows in the dorsal aspect but ventrally virtually none. (4) In *phayrei* there is a 20 mm. wide blackish band on either side in the ventral pelage about 60 mm. long. This is very faint in the Maymyo series but also in three Gokteik, one Pyaunggaung, and three Se'en specimens in the British Museum. The others in the British Museum have the ventral stripes strongly marked and agree completely in appearance with the type. Both variants were thus taken at the Se'en and Pyaunggaung localities and all in May. It is not apparently a seasonal or sexual difference, nor is it clearly a geographic variation. (5) The ears appear to be notably shorter in the Maymyo series of *phayrei* than in *caniceps*. (6) Subspecies *phayrei* lacks the seasonal orange dorsal pelage of *caniceps*.

*C. caniceps caniceps* and *C. phayrei* apparently maintain these striking pelage color differences to the opposite banks of the Salween River which separates them, and in absence of any indication of intergradation, and on the degree of difference in pelage characters, they are here confidently regarded separate species.

*C. pygerythrus janetta* is geographically adjacent to *C. phayrei* on the west and resembles it more closely than do any of the other subspecies of *C. pygerythrus*, excepting possibly the typical subspecies *pygerythrus* (which likewise is only west across the Sittang River from *C. phayrei* and resembles the rainforest population of *phayrei* almost as closely as *janetta* does the deciduous forest population). The close relationship these observations suggest, demands direct comparison of *janetta* with *phayrei*.

Just as *phayrei* shares certain color characters with *C. c. caniceps* as its closest relative to the south or east, *phayrei* shares some also with *C. p. janetta* revealing it to be the closest relative to the west. These latter are: (1) All of the dorsal pelage is a cool agouti gray excepting hands and feet and tip of tail. (2) The dorsal pelage of all four feet is not agouti but is colored like that of the venter and contrastingly lighter than that of the dorsum. (3) There is an abrupt short, black tip to the tail. (4) There is a narrow buffy midventral stripe along the tail. (5) There is some darkening of the ventral pelage in a broad band across the abdomen, tending to fade near the midline. The first three of these five characters are shared also by *C. c. caniceps*.

The important color differences between *phayrei* and *janetta* are: (1) There are five blackish bands to fully grown out tail hairs in *phayrei*, but four in *janetta*. (2) There is a flash mark on each hip of *janetta*, none in *phayrei*. (3) The hind feet of *phayrei* are nearly Warm Buff whereas those of *janetta* are but Cream Color. (4) The ventral pelage of *phayrei* is contrastingly richer in color than the mid-ventral longitudinal tail stripe, but in *janetta* they are about the same, or the venter is the more pale. (5) The side of the neck is pale, almost cream color, in *janetta*, but hardly lighter agouti than the nape in *phayrei*.

There is an important general size difference between *phayrei* and *janetta* which is fairly well indicated by hind foot measurements of both these forms taken in the field by the same collector, Gerd Heinrich. These are: *janetta*, 40, 40, 40, 43 mm.; *phayrei*, 43, 45, 46, 47, 48, 48 mm. *C. phayrei* has been taken at Ava west of the Irra-Sittang Valley and *janetta* east of it at Mandalay. Since there is at least this small area of sympatric distribution, then, and no evidence of intergradation in the available material, *C. pygerythrus janetta* and *C. phayrei* are here accepted as separate species.

The form *phayrei* is separated from *C. erythraeus atrodorsalis* and *C. e. zimmeensis* by the apparently quite effective barrier of the Salween River. Since *phayrei* also differs in color characters of the pelage from both *zimmeensis* and *atrodorsalis* a great deal more than it does from *C. e. sladeni* or *C. c. caniceps*, it seems unquestionable that *phayrei* is of a distinct species, and no details for comparison with *zimmeensis* and *atrodorsalis* seem necessary here.

*C. phayrei* has here been accepted as different at the species level from all tree squirrel forms to the south, west, east, and northeast of its known range that, like *phayrei*, ordinarily have only two pairs of functional mammae. It is separated from these other species to the south and west by the Salween River, and from a species to the northeast by the Irrawaddy River, and was formerly separated from two species to the east by a river barrier (the Irra-Sittang). There remains only to ascertain the relationship of *phayrei* to the form immediately to the north and northwest. This is *C. flavimanus shanicus* which occurs in the area between the Salween and Irrawaddy rivers and has no barrier separating it from *phayrei*.

The trenchant differences between *phayrei* and *shanicus* in pelage color are: (1) All four feet of *shanicus* are blackish agouti like its dorsum, but those of *phayrei* are yellow or yellow-orange like its venter. (2) The ears of *shanicus* have the reddish rims, but those of *phayrei*

are plain agouti like its back. (3) The ventral aspect of the tail of *shanicus* is as plain as the dorsal, but that of *phayrei* is ornamented by a longitudinal yellow midstripe. (4) The back of *shanicus* has a faintly expressed, broad, blackish, longitudinal band on the posterior two-thirds of the middorsum, but the back of *phayrei* is plain agouti like its sides, nape and crown. (5) The ventral pelage of *shanicus* is (somewhat obscurely) bisected by a longitudinal narrow stripe of agouti pelage, but that of *phayrei* has no such division. (6) the rostrum of *shanicus* shows more or less suffusion of rusty red, but that of *phayrei* is cool agouti like its crown. (7) The ventral pelage is generally a dull gray, but that of *phayrei* is a bright yellow-orange (sometimes with broad black margins extending between the fore and hind limbs).

The first six of the above color characteristics of *shanicus* are generally shared with *C. f. gordonii*, *zimmeensis*, *atrodorsalis*, *thai*, and other forms of *C. flavimanus* to the east and south indicating a conspecific relationship with them while separating *shanicus* from *phayrei* at the species level. Species distinction between these two is further indicated by both of them having been taken at precisely the same altitudes at three of the same localities, Maymayo, Gokteik, and Pyaunggaung, and there is a 100-mile north-south sympatry in their ranges indicated by mappable collecting localities. (See account of *C. f. shanicus* for further details.)

Thus, the form *phayrei* is clearly distinct at the species level from all other tree squirrels of its subgenus which surround it on every side, and if one accepts *blanfordi* and *heinrichi* as synonyms of it, *phayrei* is a monotypic species.

Shortridge's field note on *phayrei* (in K. V. Ryley, 1914, p. 721) may shed light on the distributional relationship between *phayrei* and *shanicus*: "A particularly active species, its leaps from tree to tree almost rivaling those of *Ratufa*. Around Hsipaw town and Se'en, even more plentiful than . . . *shanicus*. Not observed at Maymyo." In contrast he found *shanicus* the most abundant squirrel in Hsipaw State habitually near bungalows around Maymyo.

What evidence we have suggests the possibility that *C. f. shanicus* and *C. phayrei* may be in active competition with one another where their ranges meet or overlap and even that *phayrei* may be replacing *shanicus* in accordance with the "competitive exclusion principle" (Hardin, 1960). *C. ferrugineus* also seems to be involved in this, but more locally and perhaps to a very minor extent making it three-way competition.

**Callosciurus inornatus** (Gray)

*Macroxus inornatus* Gray, 1867, Ann. Mag. Nat. Hist. (ser. 3), 20, p. 282.

*Callosciurus imitator* Thomas, 1925, Proc. Zool. Soc. London, 1925, p. 502.

*Types*.—*M. inornatus* BM No. 62.8.18.4, an old female from mountains in Laos, taken by C. Mouhote; *imitator*, BM No. 25.1.1.-68, adult male from Thai-Nien, latitude 22° N. on the Song Koi, Tonkin, 300 feet, collected February 26, 1924, by H. Stevens.

*Material examined*, from Annam.—Hoi Xuan (CNHM), two; "Muong Sen," prov. Vinh (BM), one, (MNHN), one; Phu Qui (BM), three, (MNHN), eight; Lao Bao (MNHN), one; "Ipuing" (MNHN), one.

*Material examined*, from Tonkin.—Phong Tho, 1000 feet (AMNH), one, (CNHM), one; Bac Tan Tray, 700 feet (AMNH), one; Lai Chau, 500 feet (AMNH), two, (ANSP), one, (CNHM), one, (USNM), three; M. Mouen (AMNH), two, (ANSP), eight; Na Hai (AMNH), two; Ba Nam Nung (CNHM), one; Muong Mo (CNHM), 12; Muong Moun 1200 feet (CNHM), nine, (MCZ), one, (UMMZ), one; Muong Boum (CNHM), 11, (MCZ), two; Nong Lum (CNHM), one; Lieng San, 1500 meters (CNHM), six; Chapa (CNHM), four, (MCZ), two, (BM), 10; Pakha (CNHM), one, (BM), two.

*Material examined*, from Laos.—Muong Yo, 2300 feet (CNHM), 14, (USNM), two; Napé, 2000 feet (BM), four; Pasa (AMNH), one; Xieng Khouang (BM), one; Don Qua (AMNH), one; Muong Koa [Khoua] (USNM), one; Nam Khueng (MCZ), two; Phu Kobo (MCZ), two; Lo Tiao (MCZ), two; Col de Taloun (MCZ), one; Phong Saly 4400 feet (MCZ), one, (UMMZ), one, (CNHM), three; "Tha Ngon," Vientiane (CNHM), one; Vientiane (USNM), one.

*Systematic history*.—Gray's original description of *inornatus* fits the squirrel known since 1925 as *imitator*, quite well in every way excepting the last item on the tail: "Fur olive-grey . . . throat, inner side of limbs, and [venter] pale bluish grey, washed with whitish; feet like back; tail longer than the body and head, colored like the back, with elongated white-tipped black hairs at the tip; hairs of the tail yellow, with three black bands . . ." One of us (Tate) examined the type in 1951, noted it to be very much like the type of *C. pygerythrus stevensi*, but did not compare it with "*imitator*," and photographed and measured the skull. There is no doubt from the skull that this is *Callosciurus*, and there is no other *Callosciurus* species known from Laos which the type of *inornatus* reasonably could represent. Badly worn tails sometimes have the ends of the hairs broken off enough to



reduce the count of black color bands, and tails with the hairs not yet grown out to full length do not show the full number of black bands.

Thomas (1925) in describing *imitator* from Tonkin did not compare it with *inornatus* Gray and seemed unaware of the existence of *inornatus*, for he remarked the peculiarity of its possible relationship to the *C. caniceps* complex and noted its "superficial resemblance" to *C. pygerythrus stevensi*. Robinson and Kloss (1918) had overlooked *inornatus* in their nominal list of the squirrels of the Oriental Region.

*Pelage color*.—Ventral pelage generally Light Violet Gray from chin to wrists and ankles. In the 68 specimens at Chicago Natural History Museum there is occasionally a collar of agouti intruded into this ventral pelage and a wedge of it extending posteriorly on the midline or a midstripe of it bisecting the bluish ventral pelage. The chin pelage is almost invariably bluish gray. Excepting for minor individual variations of lighter or darker, there seems to be no other variation in the ventral pelage of this great series excepting the only summer specimen CNHM No. 32381 from Tha Ngon, Vientiane, Laos. This exception has a rather general suffusion of agouti throughout the ventral pelage. (Since the Vientiane specimen is from an area on the edge of the known species range and rather distant from sources of other material examined, one wonders whether the variation might be geographic. A perhaps similar condition in an AMNH specimen from Na Hai, near Dien Bien Phu, suggests that the variation may be individual.)

The dorsal pelage is agouti, with two or often three light bands on the individual hairs, and Deep Olive (XL) in color. It varies astonishingly little in the large series at Chicago Natural History Museum. (There is some reddish suffusion the length of the dorsum, however, in 10/12 of the Muong Mo series and all 11 from Muong Boum, but it is poorly developed in the Lieng Sen six and Muong Mouen eight and virtually absent from the Phong Saly and Muong Yo series.) The ears are the same as the dorsal pelage; the feet are only a little more contrasty agouti. The tails are colored like the dorsal pelage and regularly but sparingly black-tipped (50 or 60 mm. black on light tipped hairs) throughout. The tail hairs regularly have five blackish bands on the individual hairs when the hairs are fully grown out, but one AMNH specimen has six. Table 10 provides measurements of two specimens which give some indication of the dimensions of this animal.

This is a smaller squirrel than *Callosciurus erythraeus hendeei* with which it is almost completely sympatric (and which also shows re-

markably little geographic variation in color characteristics). Compare Figures 13 and 15.

*Diagnosis.*—In describing *imitator* (= *inornatus*) Thomas noted its striking similarity to *Callosciurus caniceps concolor* far to the south in Malaya and to *Callosciurus pygerythrus stevensi* far to the northwest in Assam. *C. inornatus* has, however, a considerable number of somewhat varying pelage characteristics which together easily distinguish it from *C. p. stevensi*: (1) The ordinary number of blackish bands on the tail hairs is five rather than four. (2) The tail is colored dorsally the same as the animal's back instead of paler and grayer. (3) The tail is lighter colored ventrally than dorsally but is yellowish brown instead of cool gray. (4) There is no flash mark of lighter color on the dorsal pelage of the hip as is common in *stevensi*. (5) The feet and forelegs are colored like the back instead of being notably more gray. (6) The subterminal light bands on the tail hairs are too short (ca. 2 mm.) and too yellow to give any special impression as to the color of the tail hair tips, whereas in *stevensi* their whiteness and length (ca. 3 mm.) give an impression of whitetipped hairs.

Although *C. caniceps concolor* is most like *C. inornatus* in pelage characteristics, *inornatus* is geographically remote from *concolor*. On the other hand, *C. inornatus* is separated from the range of *C. c. caniceps* only by the Mekong River. Because of this proximity to *caniceps* it is important to consider the amount of difference between *inornatus* and *C. c. caniceps*: (1) *C. inornatus* does not have a seasonal change of the dorsal pelage to orange but remains agouti gray (as do the subspecies of *C. caniceps* to the south of *C. c. caniceps*). (2) *C. inornatus* has agouti feet concolorous with the pelage of its dorsum instead of contrastingly pale gray. (3) *C. inornatus* has a vaguely delineated black pencil to its tail, obscured by whitish tips on the elongate hairs that compose it and varying amounts of light banding basal to the black on these hairs, unlike the crisply all black and sharply defined black tail tip of *C. c. caniceps*. (4) *C. inornatus* is substantially smaller than *caniceps*, greatest skull length of adults being about 51 mm. compared to 58 mm. in *caniceps*. (5) The rostrum and ear tips are colored like the back in *inornatus* (the tip of the rostrum tending a little toward black) instead of being quite whitish as in *C. c. caniceps*. (6) *C. inornatus* seems generally to lack the rather prominent longitudinal stripe of agouti which bisects the bluish gray venter of *caniceps*.

*Relationships to other species.*—*C. inornatus* is almost wholly sympatric with *C. erythraeus hendeei*, and was taken without any evidence

of interbreeding in many of the same localities, and (when the elevation was given on the specimen tag) at the same elevation. Since *inornatus* is, furthermore, a smaller squirrel than *hendeei*, we do not question (nor has anyone) that they are specifically distinct. *C. inornatus* is separated from all of the subspecies of *C. pygerythrus* by two great barrier rivers, the Salween and the Mekong, and earlier the Irrawaddy must have constituted a third. It is shown above that *inornatus* generally has a good many differences in pelage color from the subspecies of *C. pygerythrus* that it most closely resembles.

We recognize that the barrier strength of the great rivers may weaken to the north, that some other tree squirrel species are separated into populations of no more than subspecific rank by any one of these river barriers in the north, and that *C. pygerythrus stevensi* is the northernmost subspecies of its species. These things do seem to support Ellerman and Morrison-Scott (1951, p. 488) in treating the species *pygerythrus* as the nearest relative of *inornatus*. On the amount of pelage color difference between *inornatus* and *C. p. stevensi*, the great gap in known distribution between them (a gap from which specimens of other tree squirrel species are nevertheless represented in the collections available to us), and the interposition of the several major rivers as filter barriers, however, we cannot accept a subspecific relationship between *inornatus* and *stevensi* and conclude that these two forms are specifically distinct.

Whether the species *Callosciurus pygerythrus* is indeed the closest relative of *Callosciurus inornatus* is to be questioned next. The differences between *C. inornatus* and *C. c. caniceps* described above are numerous and trenchant, but those between *C. inornatus* and *C. caniceps concolor* are exceedingly few. This close similarity between *inornatus* and *concolor* becomes significant in view of the following considerations which are emerging from the present study: (1) The Malay Peninsula below the Isthmus of Kra is a large mountainous area of little-differentiated tropical rainforest, virtually without seasons, and this region appears to provide many niches for tree squirrels in which they remain conservative in pelage color. (2) Tonkin and upper Laos constitute an area which seems to have fewer niches for tree squirrels, but where they are similarly conservative in pelage color. (3) Thailand, excluding the peninsular portion, in strong contrast with Malaya, contains large tropical lowland forest areas which differ sharply in annual rainfall, and have prominent alternating dry and rainy seasons, and in it tree squirrels develop the most fantastically colored pelage.



It seems reasonable to conceive that when *Callosciurus caniceps* first over-ran Thailand and spread throughout the area that is the present range of *C. caniceps* (Malaya to northern Thailand), it would then have had color characters much like *concolor* or *inornatus* throughout this range. Only two changes are needed then to achieve present conditions. (1) A stream piracy of the Mekong River by one of its own tributaries could have removed a substantial area from west to east of the Mekong River. A hypothetical example: the course of the Mekong might once have been through the valley which the Nam Tha now drains but was subsequently diverted to its present channel by head erosion of a recurved western tributary. This would have the effect of isolating a large population of this new species *C. caniceps* and freeing it to spread elsewhere east of the river. A population so separated from the species *caniceps* would reasonably be expected to have spread to the limits now known for *inornatus* and to have conserved rather well the pelage characters with which it arrived. (2) The population of species *caniceps* remaining west of the Mekong in the main part of Thailand would have evolved other pelage characteristics which would be the trenchant and extraordinary ones now observable in *C. c. caniceps*.

That *C. inornatus* thus may be directly derived from *C. caniceps* instead of *C. pygerythrus* does not appear to have been seriously considered before, but may now be regarded as the more probable relationship as a matter of minimum hypothesis. If *inornatus* is derived from species *caniceps*, there is an interesting niche reversal where sympatric with species *flavimanus*, for *C. c. caniceps* is the larger squirrel than *C. f. tachin*, and *atrodorsalis* and *thai*, but *C. f. hendeei* is the larger squirrel than *imitator*.

### ***Callosciurus pygerythrus* (Geoffroy St. Hillaire)**

*Definition.*—The species *pygerythrus* includes subspecies *pygerythrus*, *janetta*, *owensi*, *mearsi*, *stevensi*, *blythi*, and *lokroides*, and their synonyms. These occur principally east of the Sittang and upper Irrawaddy valleys to the edges of the Indochinese Subregion as shown in Figure 16.

*Diagnosis.*—The fully grown-out tail hairs of this species have but four blackish bands. There is a seasonal flash mark in the pelage of the thigh which contrasts with the ordinary agouti dorsal pelage by being lighter (about cream color in most subspecies, but ochraceous buff in some). These characters distinguish *pygerythrus* from sympatric species and adjacently allopatric ones.



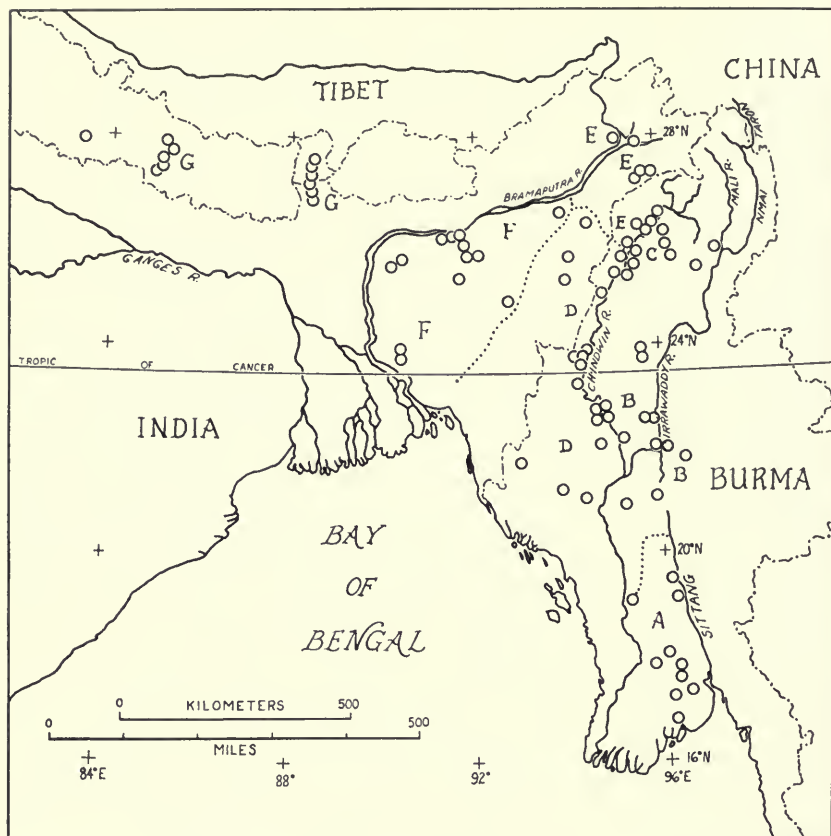


FIG. 16. Geographic distribution of the Irrawaddy squirrel, *Callosciurus pygerythrus*, as determined from material examined. Subspecies: A, *pygerythrus*; B, *janetta*; C, *owensi*; D, *mearsi*; E, *stevensi*; F, *blythi*; and G, *lokroides*. Dotted lines separate subspecies as known from specimens from the localities plotted but are not offered even as potential boundary lines between the subspecies.

*Relationships to other species.*—This is a species of tree squirrel that is of smaller size than a species of tree squirrel generally attains in a hospitable geographic area which it occupies alone. Throughout virtually all of its range *pygerythrus* is sympatric with a larger species of tree squirrel, either *Callosciurus erythraeus* or *C. ferrugineus*. Compare their dimensions as indicated by Tables 11 and 4. This geographic range is constituted by those parts of Burma, India, and Pakistan which lie west of the Irrawaddy and Sittang rivers and east of the Brahmaputra River. An additional strip west of the Brahmaputra extends along the southern face of the Himalayas beyond the

middle of Nepal. There is also a very small area that this species has invaded eastward across the Sittang Valley in the vicinity of Mandalay.

It is shown in the account of *Callosciurus phayrei* that *phayrei* is the closest relative of *Callosciurus pygerythrus* and that through *phayrei*, *pygerythrus* is next most closely related to *Callosciurus caniceps*. It is interesting that John Anderson (1879, p. 231) ventured much this same opinion about a definite interrelationship of *pygerythrus*, *phayrei*, and *caniceps*, from examination of a substantial series, but he was speculating that they are all one species.

*Intraspecific variation.*—In subspecies *lokroides* the term "winter pelage" may be perfectly acceptable to distinguish the duller pelage of winter from the very much brighter pelage of summer. However, Raven collected subspecies *mearsi* in dull "winter" pelage without flash marks on the hip in March at several localities directly across the Chindwin River from where he was collecting subspecies *owensi* at the same time in bright "summer" pelage with flash marks. Shortridge (in Wroughton, 1916, p. 293) remarked no pronounced difference in the character of the forest on the two sides of the Chindwin River at these places, between Hkampti and Tamanthe. The pelage of two subspecies being out of phase across the river barrier raises some question as to whether the terms "winter" and "summer" pelage are in fact suitable terms to be applied to these subspecies of lower latitude and elevation. Perhaps "eclipse" pelage would be better terminology for the dull pelage, where a distinctive alternation occurs.

We have examined and compared summer and winter specimens of the subspecies *janetta*, which occupies the dry scrub forest of the dry zone of central Burma, but the differences between these are so slight that one can hardly claim there are seasonally bright and dull pelages in *janetta* at all. The flash mark on the hip is present in all specimens of *janetta*. Part of what we recognize here as *mearsi* west of the lower Chindwin and lower Irrawaddy also occurs in the extreme dry zone of central Burma. Material of *mearsi* collected in winter in this zone is, of course, distinct from *janetta*, but surprisingly resembles it in having a flash mark on the hip; whereas the large winter season series of *mearsi* from the deciduous forest zone seems to be in dull seasonal pelage and has no flash mark on the hip. Thus, we have a species which as a whole seems to alternate dull pelage (and no flash mark) with bright pelage (and flash mark). But within this species is one subspecies, *janetta*, and part of another, *mearsi*, that unlike the rest of the species occur in the scrub forest of a nearly

TABLE 11. Dimensions of Some Type Specimens of the Species *Callosciurus pygerythrus*.

NAME	BODY			SKULL						
	Head & Body	Tail	Hind Foot	Total Length	Mas-toid Breadth	Length Nasal	Dia-stema	Length Palate	Length Bulla	Maxillary Tooth-row
<i>pygerythrus</i>	190 ±	110 ±	43 ±	....	....	13.2	11.0	22.3	...	7.9
<i>janetta</i>	198	199	50	49.5	19.4	12.5	10.2	21.7	9.0	8.3
<i>owensi</i>	216	202	49	50.8	20.8	15.7	12.2	25.4	9.0	9.0
<i>mearsi</i>	185	172	..	45.7	20.2	13.9	10.2	22.8	8.4	8.7
<i>bellona</i>	184	176	48	46.0	19.5	13.8	10.7	23.3	8.8	8.4
<i>virgo</i>	180	160	44	47.2	20.0	13.8	9.8	22.9	8.5	8.3
<i>stevensi</i>	230 ±	190 ±	48	....	....	14.7	11.8	24.0	...	9.0
<i>lokroides</i>	210 ±	160 ±	45	....	20.8 ±	14.4	11.7	24.6	8.9	8.3
<i>lokroides</i> <sup>1</sup>	200 ±	160 ±	46	47.3	20.1	14.1	11.0	23.7	8.9	8.4
<i>assamensis</i>	180 ±	100 ±	..	....	....	14.3	10.7	22.8	...	8.1

<sup>1</sup> *C. p. lokroides* is represented by two cotypes, the second a young adult.

desert area. Both of these have flash marks in the winter pelage and other reductions in the amount of seasonal difference in color of pelage.

The pelage characters which distinguish the subspecies of the species *pygerythrus* are relatively inconspicuous ones, and in order to distinguish them we were obliged to write down lists of the color characters of each series and test them empirically to see what does distinguish each alleged subspecies from the others geographically adjacent to it. This procedure resulted in valuable, recorded descriptions and diagnoses easily included in the present paper. The characters of subspecies of other species have generally been better known and easier to observe and remember, and such time-consuming procedure as employed with *pygerythrus* was not necessary nor practical for so extensive a study as the present one.

### ***Callosciurus pygerythrus pygerythrus* (Geoffroy St. Hilaire)**

*Sciurus pygerythrus* Geoffroy St. Hilaire, 1832, Mag. Zool., Paris, fifth unnumbered page for Pls. 4, 5, and 6, Cl. 1; see also 1834, Geoffroy St. Hilaire, in Belanger, Charles, Voyage aux Indes-Orientales. Zool. p. 145 in text, pl. 7 in atlas.

*Type*.—MNHN No. 1829-286(294), adult from forest of Syriam, near Pegu, Burma, collected by Charles Belanger.

*Material examined*, all from Burma.—“Camp Pinmezali,” 850 feet, Pegu Yoma (AMNH), one; “Yetho River,” 100 feet, Pegu Yoma (AMNH), five; “Kathipinzan,” 100 feet, Pegu Yoma (AMNH), two; Hmawbi, 40 km. north of Rangoon (AMNH), one; Shandaw, 125 km. north of Rangoon (AMNH), one, 30 km. north of Prome (AMNH), six; Zaungtu, 30 miles north of Pegu (CNHM), one; Tamabin, 200 feet, 25 miles north of Pegu (CNHM), one, (BM), three; South Zamaya Reserve, 45 miles north of Pegu (BM), one; 20 miles north of Toungoo (BM), one; 30 miles north of Toungoo (BM), one; 40 miles north of Toungoo (BM), two; Rangoon (BM), four; “Tenasserim” (BM), one; Pegu (BM), three.

*Pelage color*.—Description from series in American Museum of Natural History: (1) The dorsal pelage is about Olive Brown (XL) from rostrum almost to tip of tail, and hardly lightens on the ears or sides. (2) Dorsal pelage of the feet is agouti but is appreciable lighter than dorsum. (3) The sides of the neck are like the feet. (4) There is a short black tip to the tail. (5) Blackish bands on individual tail hairs are as many as four. (6) Ventral pelage is Cinnamon Rufous (XIV) but with the chin, throat, and breast Pale Ochraceous Buff to Light Ochraceous Buff (XV). (7) Perineal pelage does not differ, or a small amount of it is lighter. (8) The midventral, longi-



tudinal, tail stripe is pale and feebly expressed in most (but brilliant and strongly expressed for full length of tail in the Shandaw specimen).

*Diagnosis.*—The subspecies *C. p. pygerythrus* is distinguished from the known adjacent conspecific subspecies by the above characteristics as follows: From *C. p. janetta* by Nos. 1, 2, and 6.

*Discussion.*—Our measurements in Table 11 and photographs studied of the skull of the type specimen leave us in no doubt that its nearest relative is *janetta*. The type has no flash mark on the hip and the two specimens in the Chicago Natural History Museum collection, which were both taken in January, have none. Since the American Museum of Natural History material, which was taken April 28, May 7–11, and September 10–16, all has the flash mark present, it becomes evident that this purely tropical subspecies has a seasonal change of pelage resembling those of the more northern subspecies in that the flash mark is present on the hip during the summer (rainy) season and absent during the dry winter. In this *C. p. pygerythrus* differs from *C. p. janetta*, for *janetta* has the flash in both summer and winter.

Interestingly enough the American Museum of Natural History material of *C. p. pygerythrus* shows striking evidence of molt in April and May as well as September, suggesting two molts a year as the mechanism by which the observed difference in seasonal pelage is brought about.

The material from 30 kilometers north of Prome is distinctly intermediate in pelage color characters between *C. p. pygerythrus* and *C. p. janetta*. Prome is about where de Terra (1944, fig. 4) draws the line between the vegetation zone "Delta and Swamp Forest" on the south and "Dry Scrub Forest" on the north. Since all of the locality records for *C. p. janetta* are to the north in the Dry Scrub Forest Zone and all the *C. p. pygerythrus* localities found are in the zones of Delta and Swamp Forest, Deciduous Forest, and Rainforest which lie south of the Dry Scrub Forest Zone, the hypothetical line along which *C. p. pygerythrus* and *C. p. janetta* are presumed to intergrade approximates the southern margin of the Dry Scrub Forest.

### ***Callosciurus pygerythrus janetta* (Thomas)**

*Sciurus pygerythrus janetta* Thomas, 1914, Jour. Bombay Nat. Hist. Soc., 23, p. 203.

*Type.*—BM No. 14.12.1.4, adult male from Mandalay, 200 feet, collected June 28, 1913, by Guy C. Shortridge.

*Material Examined*, all from Burma, and all from east of the Chindwin River.—Okma (AMNH), seven; Mingun, west of Sagaing (CNHM), two, (BM), eight; "Gada," *Shwebo* (BM), one; "Kyon-daw," *Kawlin*, *Shwebo* (BM), one; "Kayikthin," *Shwebo* (BM), one; Mandalay (BM), six; "Myitnge River," 500 feet, *Maymyo* (BM), one; Monywa (BM), one; "Nyoring Vintha," east bank of Irrawaddy (BM), one; "Pyawbwe," 700 feet (BM), two; Wuntho, *Shwebo* (BM), one; Yin, Lower Chindwin River (BM), seven; Mt. Popa, 600 meters (AMNH), three, (BM), five; 20 km. north of Meiktila (AMNH), one.

*Pelage color*.—(1) From Okma, Mt. Popa, and Meiktila material, *janetta* is seen to possess agouti dorsal pelage about Grayish Olive (XLVI) in general aspect. (2) This color is exceedingly uniform from back to crown, ears, tail, sides, or legs. (3) There is a rather small Cream Color flash mark on the hip in the dorsal pelage. (4) The edge of the flash mark is contiguous with the edge of the ventral pelage, and not separated from it. (5) All four feet are cream colored on the digits and often on the whole foot. (6) There is a rather inconspicuous short black tip to the tail. (7) There are up to four blackish bands on the tail hairs. (8) The ventral pelage is about Light Ochraceous Buff (but in extreme individuals is Pale Ochraceous Buff or Ochraceous Buff), which is slightly buffier than the flash mark. (9) The ventral pelage is gray on the basal portion of the individual hairs in a broad band across the abdomen. (10) The mid-ventral pelage of the tail is about Ochraceous Buff proximally for about the middle third of its width, but diminishing distally both in width and intensity of color.

*Diagnosis*.—*Callosciurus pygerythrus janetta* may be distinguished from geographically nearest conspecific subspecies by the above enumerated color characters as follows: from *C. p. owensi* by nos. 1, 3, 4, 5, 8, and 10; from *C. p. mearsi* (as known in eclipse pelage) by nos. 2, 5, and 6; from *C. p. pygerythrus* by 1 and 8.

*Discussion*.—The difference between *janetta* and *C. phayrei* with which it is apparently sympatric in at least a small area about Mandalay and Ava, are detailed in the account of the species *phayrei*. Since at Mandalay *janetta* comes fairly close to the range of *C. flavimanus shanicus*, the differences between these two forms and possibility of intergradation need to be considered. *C. f. shanicus* differs from *C. p. janetta* in pelage color characters enumerated above for the latter as follows: Nos. 1, 2, 3, 5, 7, 8, 9, and 10. Pelage characteristics that *shanicus* possesses in common with *C. flavimanus gordonii* and/or *C. flavimanus atrodorsalis* and does not share with *janetta* are: (1)

Margins of ears are reddish. (2) Rostrum is reddish. (3) There is a faint but distinct indication of a broad, blackish band on the posterior two-thirds of the mid-dorsum. (4) The dorsal pelage of the feet is blackish agouti. (5) Although barely distinguishable there is an indication of a band of agouti longitudinally bisecting the ventral pelage.

There is also a size difference of significance between *shanicus* and *janetta* which may be seen, for example, in the hind foot measurements of the samples of these made by the same collector, Gerd Heinrich: *shanicus*, 45, 45, 47, 47 mm.; *janetta*, 40, 40, 40, 43 mm. In all, the differences between *janetta* and *shanicus* are thus obviously greater than subspecific.

We are unenthusiastic about accepting *janetta* as a single subspecies. Final decision has had to be made with only the American Museum of Natural History material at hand, and although slight but consistent differences are apparent in this between the samples from the populations separated by the Irrawaddy River, the sample from north of the river is all from one locality. When some future student is able to investigate this with material better representing the range of *janetta* on both sides of the river, he may find it necessary to recognize them as two subspecies.

### ***Callosciurus pygerythrus owensi* (Thomas and Wroughton)**

*Tomeutes similis owensi* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 236.

*Type*.—BM No. 15.5.5.189, old female from Minsin, 450 feet, upper Chindwin River, Burma, collected August 15, 1914, by G. C. Shortridge and S. A. Macmillan.

*Material examined*, all from Northern Burma, *between* the Chindwin and Irrawaddy rivers.—Lonkin (AMNH), one; Mansum (AMNH), two; Pumsin (AMNH), one; Limpa (AMNH), two; Kaunghein (AMNH), three; Moklok (AMNH), four; Phawzaw (AMNH), two; Tamanthe (AMNH), two; Hkamti (BM), one; Kauktaung (BM), one; "Northern Burma" (AMNH), one.

*Pelage color*.—Seventeen American Museum of Natural History specimens come from eight localities, two of the eight straddling the type locality and about five miles from it. These were taken between January 14th and March 18th. (1) The dorsal pelage is agouti and in the mid-dorsal, more reddish portion appears about Cinnamon Brown (XV). (2) The sides and hind legs are agouti but not reddish and

appear about Light Brownish Olive (XXX). (3) The reddish color of the back diminishes very gradually anteriorly and is generally faint on the nape and absent from the crown and ears which are about the color of the sides but slightly darker. (4) There is a buffy eye ring. (5) The pelage on the foot is the same color as that on the leg. (6) The reddish color of the middorsum continues posteriorly for most of the length of the tail. (7) Buffy subterminal bands on the tail hairs provide a noticeable buffy fringe. (8) The tip of the tail is black for about the distal half of the terminal hairs. (9) The flash mark on the hip is Ochraceous-Buff (XV). (10) The flash mark (in all but one case) is separated from the ventral pelage by some agouti dorsal pelage. (11) The ventral pelage is longitudinally divided by a thin midstripe of dark pelage. (12) The ventral pelage has light color, or long light tips which give it an overlying color, of Light Ochraceous-Buff (XV), but dark gray bases to the hairs, everywhere but the axils and groin and sometimes the forelegs. (13) The perineal pelage of adult males is more richly buffy colored than the general ventral pelage of the same animal. (14) The ventral color of the tail lacks the reddish dorsal infusion and has no proximal midventral intrusion of strong buffy color.

*Diagnosis.*—*Callosciurus pygerythrus owensi* is distinguished by the above described winter pelage characteristics from *C. p. stevensi* to the north by nos. 5, 11, and 12; from *C. p. mearsi* to the west by nos. 1, 6, 7, 8, 9, and 13; from *C. p. janetta* to the south by nos. 1, 2, 5, 6, 7, 9, 10, 11, 12, and 13.

*Discussion.*—The winter pelage of subspecies *owensi* suggests strong affinities between *owensi* and *stevensi* in the dark-colored dorsum with a reddish middorsal infusion, in the presence of a flash mark on the hip in winter pelage, in the rich color of the flash mark, in the presence of gray bases to the ventral pelage of the hind legs, breast, and throat. Some direct interbreeding with *mearsi* despite the Chindwin barrier is certainly suggested by the divided venters seen in the northern *mearsi* material.

The type description by Thomas and Wroughton is of an animal in summer pelage, and since we cannot provide better detail, we quote it. "General ground color above essentially the same dark grizzled olive gray as in [summer pelage of *lokroides*], but the whole back strongly suffused with deep rufous, becoming stronger posteriorly, the loins practically grizzled 'chestnut,' passing without contrast into the ferruginous of the hip-patch. Head, neck, shoulders gray. Under-surface buffy, a more or less distinct grizzled gray line



running down the center from throat to belly; a small central patch in inguinal region whitish. Inner sides of forearms whitish, of legs strong buffy. Hands and feet grizzled gray with or without buffy intermixture. Tail coarsely grizzled gray with but slight buffy suffusion; the terminal hairs black."

### **Callosciurus pygerythrus mearsi** (Bonhote)

*Sciurus lokroides mearsi* Bonhote, 1906, Ann. Mag. Nat. Hist. (ser. 7), 18, p. 338.

*Tomeutes mearsi bellona* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 420.

*Tomeutes mearsi virgo* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 421.

*Types*.—*S. l. mearsi*, BM No. 6.7.5.10, old female from Chinbyit on a west bank tributary of the Chindwin River, collected January 16, 1906, by A. Mears; *bellona*, BM No. 15.5.5.177, old male from Kin, Lower Chindwin River, Burma, collected June 18, 1914, by G. C. Shortridge; *virgo*, BM No. 15.5.5.169, adult male from Tatkon, near Kindat, Upper Chindwin River, Burma, collected July 5, 1914, by G. C. Shortridge.

*Material examined*, from Burma, and all from *west* of the Chindwin River.—Mt. Victoria, Pakkoku Chin Hills (AMNH), one; Dudaw-Taung, Pakkoku Chin Hills (AMNH), one; Kyundaw, 30 km. northwest of Seikpyu (AMNH), six; Kalewa (AMNH), 11; Mawlaik (AMNH), three; Kindat (AMNH), two, (BM), four; Homalin (AMNH), 20, (BM), four; Tempao (AMNH), eight; Tamanthi (AMNH), one, (BM), four; Phawzaw (AMNH), one; Kin (BM), 11; Okma (AMNH), three; Moklok (AMNH), one; "Magaung," lower Chindwin (BM), one; Tatkon (BM), seven, (CNHM), two; "Aingma," lower Chindwin (BM), one; Sangau, Lushai Hills, (CNHM), four; Kabaw Valley, 20 miles west of Kindat (BM), two; Chaung, 20 miles n.n.w. of Kindat (BM), one.

*Material examined*, from Assam.—Kohima, Naga Hills (CNHM), two; Karong, Manipur (CNHM), one; "Therighat," Manipur (BM), one; Mokokchung, 4500 feet, Naga Hills (BM), one; Margherita (BM), two; "Sangrachu," 3000 feet, Naga Hills (BM), one; Golaghat, 400 feet (BM), five; Thotal [Thobal], Manipur (BM), one; "Naga Hills" (BM), one; "Namdang" Naga Hills (BM), one.

*Pelage color*.—The following description is from the American Museum series of 55 specimens from 11 localities between Moklok and Mt. Victoria 325 miles to the south. The ones from Chindwin

River localities are all in eclipse pelage having been taken between March 16 and April first. The ones from farther south at Kyundaw and Dudaw-Taung were collected between January 28 and 29, but the Mt. Victoria specimen was taken on July 2nd and is in summer pelage. (1) The agouti dorsal pelage is generally about Buffy Brown (XXX) but on some few specimens is Light Brownish Olive. (2) In the winter pelage there is a pronounced tinge of Isabella Color in the agouti dorsal pelage, most intense across the shoulders (and quite prominently so when series are laid out) but often coloring the sides, also (quite like character no. 2 of *lokroides*). (3) There is an eye ring buffy enough in color to contrast well with the agouti pelage of the face and often wide enough to be quite conspicuous. (4) The flash mark on the hip is white. (5) The ventral pelage is light-colored near the tip but, when fully grown out, is contrastingly gray near the bases of the hairs at least on the area covering the abdomen. (6) There is a pair of contrastingly buffy patches of pelage on the groin. (7) Perineal pelage, if it is distinct from the other ventral pelage, is only whiter. (8) The number of blackish bands on fully grown out tail hairs is four. (9) In winter pelage the proximal, mid-ventral pelage of the tail is quite buffy and this color may extend midventrally out the tail for much of its length or not. (10) There tends generally to be a rather obscure dash of reddish color in the tail near its tip.

*Discussion.*—There is much undescribed geographic variation in *mearsi* as it is accepted here. If Thomas and Wroughton (1916, pp. 419-422) had presented adequate descriptive and other data on the collections on which they reported, it might have been possible to understand the variation in summer pelage and to present a coherent systematic account of it. One of us (Tate) has subsequently examined that summer pelage material in the British Museum and was apparently quite unimpressed by the alleged differences between *mearsi*, *virgo*, and *bellona*. Neither of us finds any characteristics in the eclipse pelage to support recognition of these named forms. However, material in eclipse pelage from the west bank of the Chindwin at Tempao, Phawzaw, and Moklok is characterized by darker ventral pelage which is longitudinally bisected by a thin agouti stripe. This material represents the three northernmost Chindwin River localities of *mearsi*. The southernmost localities are represented by midwinter material from Kyundaw and Dudaw-Taung and a summer specimen from Mt. Victoria. All of the Kyaundaw six are provided with a flash mark on the hip, and are very whitish beneath.

The summer specimen from nearby (30 to 40 miles) Mt. Victoria has notably browner dorsal pelage and a larger flash mark. These differences suggest that at Kyundaw there are flash marks in the winter pelage or that in this lower latitude there may be but one instead of two annual molts.

*Diagnosis.*—*Callosciurus pygerythrus mearsi* differs from *C. p. lokroides* by the above described characters in nos. 3, 4, and 7; from *C. p. stevensi* by nos. 1, 2, 4, 6, 9, and 10; from *C. p. blythi* by nos. 1, 2, and 7; from *C. p. owensi* by nos. 1, 2, 4, 6, 7, 9, and 10; from *C. p. janetta* by nos. 2, 3, 6, and 10; and from *C. p. pygerythrus* by nos. 2, 3, 6, 7, and 10.

*Habits.*—Morris (1936) records the following observations on *mearsi* from the field notes of Charles McCann: On p. 670 at Kalewa where the expedition took 11 *mearsi*, they “. . . were apparently feeding on the fruit of *Calycopteris floribunda*.” On p. 668 across the river from Homalin where 14 specimens of *mearsi* were taken one day, “The scrub jungle in parts seemed to be alive with this species.”

### ***Callosciurus pygerythrus stevensi* (Thomas)**

*Sciurus stevensi* Thomas, 1908, Jour. Bombay Nat. Hist. Soc., 18, p. 246.

*Type.*—BM No. 7.11.26.2, adult male, from near Beni Chang, Abor-Miri Hills, 4000 feet, Assam, India, collected February 19, 1906, by H. Stevens.

*Material examined*, from Burma, west of the Chindwin River.—Limpa (AMNH), one; Hahti (AMNH), two; Haibum (AMNH), six; Dalu (AMNH), one; 20 miles north of Hkamti on Chindwin River (BM), one.

*Material examined*, from Assam, India.—Benichang, 4000 feet, Miri and Abor Hills (BM), one; Kalek, Abor Hills (BM), one; Sadiya (BM), two; Ledo, 200 feet (BM), one; 22 miles east of Ledo (USNM), one.

*Pelage color.*—The subspecies *stevensi* is quite distinct and apparently fairly stable in the diagnostic color. (1) The agouti dorsal pelage ranges from Light Brownish Olive (XXX) to Cinnamon Brown (XV). (2) The ventral pelage is undivided. (3) The ventral pelage is composed of hairs with whitish tips that overlie but fail to hide the dark-gray hair bases, and the general effect is a bluish gray, about Pale Quaker Drab (LI). (4) A hip mark is clearly present in four of the American Museum of Natural History series (10)

and is Apricot Buff (XIV). (5) The head, hind legs, and ears are colored like the back, which pales slightly on the sides. (6) The front legs and all the feet are notably grayer than the dorsum. In a few specimens the difference is only slight but in series it is still fairly obvious. (7) The number of blackish bands on the fully grown out tail hairs is four. (8) Dorsally the tail is colored paler and grayer than the pelage of the back. (9) The tail is still a cooler gray below than it is above because the light bands on the ventral tail hairs are whitish instead of pale buff. (10) The subterminal light bands on the tail hairs are light enough and long enough (*ca.* 3 mm.) to give the gross impression that the hairs are white-tipped.

*Diagnosis.*—The characteristics of *stevensi* described and numbered above distinguish *stevensi* from the other subspecies of *pygerythrus* that are geographically adjacent to it as follows: *C. p. stevensi* is distinguished from *owensi* to the east and south across the Chindwin River by nos. 2, 3, 8, 9, and 10; from *mearsi* to the south by nos. 1, 2, 3, 4, 6, 7, 8, and 9; from *blythi* to the southwest by nos. 3, 4, 5, and 9; and from *lokroides* to the west by nos. 1, 2, 3, 6, 8, 9, and 10.

*Discussion.*—It needs to be pointed out that the Dalu specimen is the only one of the (AMNH) series taken on the east side of the Chindwin River and that the Dalu specimen is an intergrade with *owensi*, for it possesses incipient tawny groin patches, an even brighter patch (about Warm Buff) of perineal hair, faintly lighter and very faintly buffy ventral pelage on the body, and its tail does not conform to characters 8, 9, or 10 above.

The specimen of *stevensi* from Limpa is from the west bank of the river, and this locality is the most southern for the subspecies. Although the ventral pelage is typical in the Limpa specimen, there is a hint of intergradation with *mearsi* in the obvious failure of the tail to conform with *stevensi* characteristic number nine above.

The similarity between *Callosciurus pygerythrus stevensi* and *Callosciurus inornatus* and their differences are described in the account of that species.

Robinson (1913, p. 95) reports a series of *stevensi* from the Abor Hills: three from Balek, about 4 miles west of Pasighat on the west side of the Dihang; four from Rotung just south of the Dihang at 95° 10' east longitude; one from near Kalek, which is about three miles south of Rotung, and one from five or ten miles south of Kalek. Robinson (p. 89) describes this series as "very uniform and [it] agrees



well with the description of the type . . ." The present distribution of *Callosciurus pygerythrus stevensi* across the great river barrier of the Brahmaputra from the Naga Hills to the Abor Hills west of the Dihang appears to constitute a piece of zoological evidence supporting the hypothesis that the Dihang was formerly a tributary of the Chindwin and has been captured by the Brahmaputra (see Chhibber, 1934, p. 33).

***Callosciurus pygerythrus blythi* (Tytler)**

*Sciurus blythi* Tytler, 1854, Ann. Mag. Nat. Hist. (ser. 2), 14, p. 172.

*Cotypes*.—BM No. 79.11.21.361-362, adult males, both from Dacca, East Pakistan, collected by R. C. Tytler.

*Material examined*, all from Assam, India, and East Pakistan.—Umrang, Khasia Hills (AMNH), two, (CNHM), one; Nongpoh, Khasia Hills (AMNH), one; Burnihat, Khasia Hills (AMNH), seven, (CNHM), one; Palasbari (UMMZ), two, (CNHM), four; Bamanigoan (UMMZ), one; Cherrapunji, Khasia Hills (CNHM), one; Mawlyngkueng, Khasia Hills (CNHM), two; "Dilkoosha," Cachar (BM), one; "Hatikhali," 1500 feet, Cachar (BM), one; "Lanka," 400 feet, north Cachar (BM), two; "Laitkynsao," 2500 feet, Khasia Hills (BM), one; "Matunga River," 300 feet (BM), three; Tura, 1400 feet, Garo Hills (BM), one; Duragiri, 3000 feet, Garo Hills (BM), one; "Rangapani," 400 feet, Garo Hills (BM), one; Angarakhata, 300 feet, N. Kamrup (BM), two; Dacca, E. Pakistan (USNM), one; 20 miles north of Dacca, E. Pakistan (USNM), one.

*Pelage color*.—The one topotype and one near-topotype (USNM), and the material in the American Museum of Natural History are described as follows: (1) The mid-dorsal pelage is grossly about Olive-Brown (XL) grading into Buffy Brown on the sides. (2) The legs and feet are grayer and cooler than the back and sides. (3) The head is darker, grayer, and of a more contrasting agouti than the back and sides. (4) The whitish venter is about Pale Ochraceous Buff except for a substantial spot in each axil as well as in each groin, which are the richer color Light Ochraceous Buff. (5) There are as many as four blackish bands on the tail hairs, and the elongate hairs on the tip of the tail do not contrast notably in color with the rest of the tail. (6) The hip mark is present and prominent on almost every specimen and is whitish or Cream Color. (7) The under side of the tail is Light Ochraceous Buff to Apricot Buff in the middle

one-third or one-fourth of the tail's width, and in some adult specimens this color extends full strength for the whole length of the tail.

*Diagnosis.*—*C. p. blythi* is distinguished from its geographically nearest conspecific relatives by the above-numbered color characteristics as follows: *lokroides* by 3, 4, and 6; *stevensi* by 4, 6, and 7; and *mearsi* by 3 and 4.

*Discussion.*—The USNM material recently obtained from the vicinity of Dacca appears to confirm this locality, which is about 65 miles out on the Ganges-Brahmaputra delta west of any hills, as the type locality of the subspecies *blythi*. Khajuria (*in* Moore, 1960, p. 8) remarks that he has taken this form at other localities in the delta near the Garo, Khasia, and Jaintia hills in Assam. It is, thus, apparently the only diurnal squirrel of the Indochinese Subregion which has come down off the jungle-clad hills of Assam into the plains of the delta as if capable of crossing the Garo-Rajmahal Gap into the Indian Subregion. Tytler (1854) in reporting on the fauna observed while marching from Barrackpore (20 miles north of Calcutta) via Jessore and Faridpur to Dacca, remarked that during the 20 days of this march *Sciurus palmarum* [*Furnambulus pennanti*] became scarce and was not seen at all east of the Puddur River. He said it was unknown at Dacca but "it is replaced by a fine species found in the jungles and by no means uncommon. . . . They are by no means timid, but after being once disturbed and alarmed, run and hide among the branches. . . ." The details of distribution of *blythi* on the delta in relation to that of *Funambulus pennanti* would be quite interesting to know.

### ***Callosciurus pygerythrus lokroides* (Hodgson)**

*Sciurus lokroides* Hodgson, 1836, Jour. Asiatic Soc. Bengal, 5, p. 232.

*Sciurus assamensis* Gray, 1843, List Spec. Mammal. Brit. Mus., p. 143.

*Macroxus similis* Gray, 1867, Ann. Mag. Nat. Hist. (ser. 3), 20, p. 281.

*Types.*—*S. lokroides*, BM No. 43.1.12.58, old female, No. 43.1.12.59, young male, both from Nepal; BM No. 43.1.12.54, adult male, from Nepal. Probable cotypes: Leiden specimen a (no. 13364) Hodgson no. 28, old individual from Nepal; Leiden specimen b (no. 13365), Hodgson no. 62; *assamensis*, BM No. 79.11.21.584, adult, from Assam; *similis*, BM No. 43.1.12.53, and BM No. 43.1.12.54, adult male, both from Nepal.

*Material examined*, from Nepal.—Sisagarhi, 5875 feet (AMNH), two; "Nepal" (BM), five; Naggenjung, 6000 feet, Katmandu (AMNH), six; Amlekhganj (AMNH), one; "Lokoripawa," 8000 feet

(BM), two; Hetora (AMNH), one; Aromari (BM), one; Sunuchuru (BM), one; Riri Bazaar, W. Nepal (CNHM), one; Hetwada (BM), one; Katmandu, 4500 feet (BM), four; Nawacot, 7000 feet (BM).

*Material examined*, from Sikkim.—Lingtam (UMMZ), one, (CNHM), 12; Dikchu, 2000 feet (CNHM), one, (BM), one; Toong (CNHM), one; Rongli, 2700 feet (BM), four; "Sikkim" (BM), two; Rao Dala, 4500 feet (BM), two.

*Material examined*, from Bengal.—Sangsir (CNHM), four; Gopaldhara, 5000 feet, Rungbong Valley (BM), two; Mangpu, 3500 feet (CNHM), nine; Sevoke, 500 feet (BM), five; Darjeeling (BM), one; Pashok, 3500 feet, Darjeeling (BM), three; Mongtu, hills, 3850 feet, west of Tista River, Darjeeling (BM), four; Nanh laing, R. S. (BM), one; Machi, Manipur (BM), one; "Pachoe," 3500 feet, Darjeeling (BM), two; Haraincha, Morang, East Terai (BM), one.

*Material examined*, from Bhutan.—Bharnabhare, 600 feet, Bhutan Duars (BM), two; Bhotan (BM), four; Hasimara, 600 feet (BM), two.

*Pelage color*.—*Callosciurus pygerythrus lokroides* taken March (1), April (8), and May (1) may be described from the American Museum material as follows: (1) It has agouti dorsal pelage which is about Drab or Hair Brown (XLVI) which seems to have but two light bands on each guard hair. (2) The sides appear to be buffier as a result of diminishing in the total amount of black on the parts of hairs showing at the surface, and have the look of *C. c. caniceps* in the gray seasonal pelage. (3) The pelage of the head, ears, legs, and dorsum of tail does not differ appreciably in color from that of the back. (4) All four feet are appreciably cooler and grayer than the middorsum. (5) The flash mark on the hip (present only in the one summer pelage specimen) is in the area of the dorsal pelage of the leg, but borders on the ventral pelage. (6) The flash mark of the hip is Ochraceous-Orange. (7) The hairs of the tail have four blackish bands each. (8) The tail is concolorous to the end in the dorsal view (i.e., has no black or other contrasting color at the tip). (9) The ventral pelage is composed of hairs with long light tips but dark gray bases (at least on the body), and there is a tendency for the light tips to be buffy (abdominally) instead of whitish. (10) There are a pair of buffy patches of pelage on the groins (which are indistinguishable in individuals that have especially buffy general color of the venter). (11) Buffy perineal pelage is present in adults, the same color as the groin patches and in males often continuous with them. (12) Proximally the mid-ventral pelage of the tail is buffy.

*Diagnosis.*—The characteristics described and numbered above distinguish *lokroides* from geographically adjacent other subspecies of *pygerythrus* as follows: from *stevensi* by nos. 1, 2, 3, 5, 8, 9, 10, 11, and 12; from *blythi* by nos. 3 and 6; from *mearsi* by nos. 6 and 11.

*Habits.*—A collector reports field observations as follows: "Found at low elevation. At Rongli it was very partial to oranges, doing much damage to the crop. The 'dray' is a collection of grass and sticks, placed high up in a tree. This squirrel is found in heavy forest, and near villages and may often be seen on the ground searching for food. Considering the size of the animal its call is sometimes very loud." (C. A. Crump *in* Wroughton, 1916a, p. 487.)





## STRIPED TREE SQUIRRELS

### GENUS TAMIOPS J. A. Allen

*Type species.*—*Tamiops maritimus hainanus* J. A. Allen.

*Definition.*—The genus *Tamiops* is constituted by the species *mccllellandi*, *rodolphei*, *swinhoei*, and *maritimus*, and occurs virtually throughout the Indochinese Subregion as suggested by the maps of its distribution in Figures 18, 19, and 20.

The little tree squirrels of this genus range from Malaya to Hopeh, China, about the same range as that of *Dremomys* and *Sciurotamias* combined. This is a range of almost 40° of latitude and about 3000 miles. This genus occurs at low elevations in tropical rain forest in some parts of its range and up to 12,000 feet elevation in the mountains, and it is reputed to be a quiet, secretive squirrel. It has a prominent basic dorsal pattern of five longitudinal black stripes separated by four lighter stripes, and these are subject to some geographic and seasonal variations in number and intensity. The face has a prominent light stripe passing from the dorsal surface of the rostrum posteriorly beneath the eye. The tail as well as the stripes is somewhat chipmunk-like, being quite short-haired for a tree squirrel. In this genus there is characteristically a small white ear tuft. See Table 12 for an indication of size in this squirrel.

*Systematic history.*—J. A. Allen (1906, p. 475) proposed the generic name of *Tamiops*, describing characters of the molariform teeth which differ from those of *Sciurus* (a genus which then included what are now the species of *Callosciurus*). Pocock's (1923) evidence is rather equivocal on this matter of generic distinction of *Tamiops*, for although his example of the baculum in *Tamiops* differs sharply from those of some species of *Callosciurus*, it nevertheless closely resembles the example of *lokroides*. However, Robinson and Kloss (1918, p. 239) had already seized upon the generic separation of *Tamiops* and placed *Tomeutes* and six other genera between *Callosciurus* and *Tamiops* in their "A nominal list of the Sciuridae of the Oriental Region . . ." This placement, although unsupported by further evidence, has nevertheless been followed by Osgood (1932) and G. M. Allen (1940) in their extensive faunistic reports. It is especially

TABLE 12. Dimensions of Some Type Specimens of the Genus *Tamias*.

NAME	BODY			SKULL						
	Head & Body	Tail	Hind Foot	Total Length	Mas- toid Breadth	Length Nasal	Dia- stema	Length Palate	Length Bulla	Maxillary Tooth- row
1 <i>mcclellandi</i> <sup>1</sup>	115±	85±	32±	....	....	8.9	7.2	14.7	...	5.1
2 <i>manipurensis</i>	115±	100±	30	....	....	9.2	7.2	15.5	...	5.5
3 <i>collinus</i>	125	113	28	33.1	....	9.1	...	15.4	...	5.2
4 <i>inconstans</i>	112	98	28	32.7	15.0	9.0	7.6	15.6	6.1	5.0
5 <i>kongensis</i>	122	133	32	34.1	14.4	9.6	7.7	15.7	7.2	5.6
6 <i>barbei</i>	114	140	29.5	....	15.5	8.8	6.8	14.8	6.5	5.6
7 <i>noveboracensis</i>	114	95	29.5	31.0	14.1	7.7	6.5	13.3	6.0	4.8
8 <i>luciae</i>	118	117	30	....	14.7	...	6.2	14.3	6.2	5.7
9 <i>holsti</i> (= <i>lylei</i> )	105	114	28	....	....	9.0	6.7	14.3	6.9	5.6
10 <i>elbeli</i>	120	130	30	32.6	14.9	10.2	8.0	15.8	7.0	5.4
11 <i>swinhoei</i> <sup>2</sup>	140±	110±	38±	....	16.6	12.1	8.8	19.4	7.9	6.7
12 <i>clarkei</i>	155±	120±	35	....	....	12.0	8.1	18.0	7.6+	6.4
13 <i>forresti</i>	125±	100±	31	....	15.3	10.6	7.8	16.5	7.2	6.0
14 <i>olivaceus</i>	120	100	28.5	37.0	15.7	10.5	7.9	17.4	7.1	6.1
15 <i>vestitus</i>	123	88	35.5	34.8	15.3	10.4	7.5	17.1	7.6	5.7
16 <i>maritimus</i>	145±	100±	34	....	....	10.3	7.8	16.8	...	6.3
17 <i>monticola</i>	125±	120±	35	36.5	15.7	10.6	8.0	17.3	7.2	6.3
18 <i>hainanus</i>	100	95	29±	....	....	8.2	7.7	15.4	...	5.7
19 <i>laotum</i>	113	95	31	35.3	15.7	9.3	7.8	16.3	7.3	5.8
20 <i>moi</i>	123	112	33	35.4	16.1	9.1	7.8	16.4	6.9	6.2

<sup>1</sup> Nos. 1 to 7 are included in species *mcclellandi*, 8-10 in species *rodolphei*, 11-15 in *swinhoei*, 16-20 in *maritimus*.<sup>2</sup> In lieu of ascertainable type, an old adult taken by Père David at Moupin, MNHN No. 1870-39 (311).

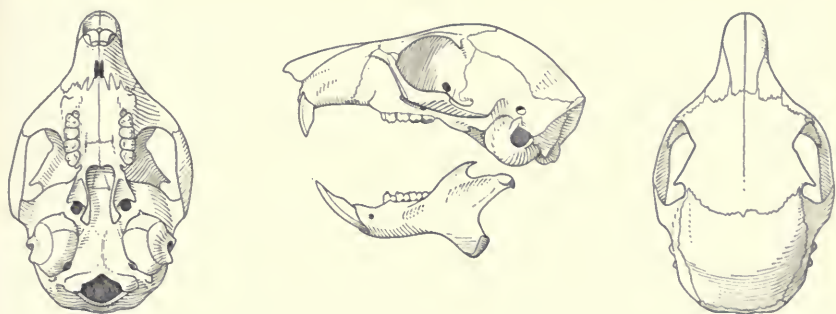


FIG. 17. Skull and left mandible of the striped tree squirrel of the Indochinese Subregion, *Tamiops*, AMNH No. 111396 of species *swinhoei*,  $\times 1$ .

noteworthy that although Chasen (1940) is too conservative to recognize the genus *Callosciurus* (as distinct from *Sciurus*) in his "Hand-list of Malaysian mammals," he does recognize *Tamiops* as a full genus and places four other genera between it and "*Sciurus*." Zahn (1942, p. 76) separated *Tamiops* further still from *Callosciurus* when he sought to make *Tamiops* a subgenus of *Funambulus*.

At the conservative extreme on the treatment of *Tamiops* Ellerman (1940, p. 347) accepted *Tamiops* as of subgeneric rank, and placed it in the genus *Callosciurus*. These treatments by Zahn, G. M. Allen, Ellerman, and Chasen are especially interesting since, being so contemporary, each presumably must have been offered without advantage of the others' thinking. Ellerman (1940, p. 350) points out that in describing *Tamiops* as a new genus J. A. Allen distinguished it only from species which are now in the restricted genus *Sciurus* and not from species of *Callosciurus*, and that diagnostic characters attributed to *Tamiops* by Allen do not in fact distinguish it from species of *Callosciurus*. In Simpson's (1945, p. 79) classification, then, *Tamiops* is included in *Callosciurus*. In a later classification of the Sciurinae (Moore, 1959, p. 198) the matter of subgeneric versus generic status for *Tamiops* was not reconsidered in any detail, and *Tamiops* was left as a subgenus of *Callosciurus*. Zahn (1942) in classifying *Tamiops* as a subgenus of *Funambulus*, ignored the evidence of their great difference shown by Pocock (1923) in the character of their respective bacula. On the basis of characters of the skull, also, Moore (1959, pp. 170, 173) has subsequently shown that *Funambulus* and *Tamiops* belong in separate tribes with the affinities Pocock had earlier attributed to them. Even in the pelage characteristics, which is Zahn's line of evidence for associating the



two, the dorsal pelage color pattern of stripes differs in several fundamental ways: (1) The midstripe and two additional pairs of stripes which are the same color as the midstripe, are the white ones in *Funambulus*, but the black ones in *Tamiops*. (2) The color of the pelage in between these stripes appears to be a rather uniformly colored area in *Funambulus* whereas in *Tamiops* it appears to be two pairs of stripes, the inner pair usually differing markedly in color from the outer pair. (3) The predominating stripes in *Funambulus* are the five including the middle one; in *Tamiops* the predominating stripes are the outer pair of the four interspaced between those five, and secondarily, the middle one of the five.

*Diagnosis.*—The recent recognition of the distinctiveness of the genus *Sundasciurus* (Moore, 1958) constituted by several species which until then had been thought to belong in the genus *Callosciurus* eliminates some of the confusion and difficulty formerly found in attempting to distinguish the species of *Tamiops* from those of *Callosciurus* on characteristics of the skull. In addition to the light stripes of the dorsal pelage, which so strongly distinguish *Tamiops* from all other Callosciurini that earlier authors have been predisposed to recognize *Tamiops* as a genus, there are now several characters of the skull which distinguish the species of *Tamiops* from the species remaining in the genus *Callosciurus*: (1) Small size associated with relatively fairly short orbit distinguishes *Tamiops* from *Callosciurus*; i.e., an orbit length of less than 13 mm. is *Tamiops*, more than 13 mm. is *Callosciurus*. (2) The midlateral processes of the basioccipital are obsolescent in *Tamiops* but generally well-developed in *Callosciurus*. (3) The upper profile of the rostrum is flat in *Tamiops*, but generally somewhat arched in *Callosciurus*. These skull characters may here be considered distinctive at the level of genus for a tree squirrel (see discussion of conservatism in tree squirrels by Moore, 1959, p. 194) phylum which is polytypic.

*Intra-generic relationships.*—Bonhote (1900) published the first revision of what is now *Tamiops*, recognizing nine forms, all as members of a single species *maclellandi*. Robinson and Kloss (1918) acknowledged 12 forms of *maclellandi*, and admitted *swinhoei* as a distinct species. Osgood (1932) considered the whole group again and listed 13 named forms of *swinhoei* as "entitled to some sort of recognition" and nine forms of *maclellandi* as "most likely to have permanent recognition." He tentatively recognized four species: *maclellandi*, *swinhoei*, *maritimus*, and *monticolus*. Subsequently G. M. Allen (1940) reduced *monticolus* to synonymy and *maritimus* to subspecies status.

Seasonal pelage changes in *Tamiops*, particularly in the nontropical parts of its range, have been found to be pronounced. It is therefore important to consider whether the specimens one examines are summer or winter skins, particularly in the forms from China. Actually the pelage appears to be virtually as long in summer skins as in winter skins.

The skulls in *Tamiops* in general exhibit great uniformity. The smallest skulls appear to be in *mccllellandi*, *barbei*, and *rodolphei*. Skulls of these forms are nearly equal in both length and breadth. The skulls of the species *swinhoei* are typically considerably larger. See Table 12. The nasals and teeth of the species *swinhoei* are in general also larger than in the remainder. The subspecies *barbei* and *rodolphei* seem to have exceptionally small teeth, leaving *mccllellandi* in an intermediate position in this respect.

The notably small size of all four *Tamiops* species (as shown in Table 12), the surprising narrowness of its tail for a tree squirrel, the flat dorsal profile of the rostrum, and the three pairs of functional mammae instead of two pairs—all suggest that the original *Tamiops* species could most reasonably have come from a stock in the Malaysian Subregion which also gave rise to the genus *Sundasciurus*, the smaller species of which may have outcompeted and replaced the *Tamiops* line there after the latter had successfully spread to the mainland.

### ***Tamiops mccllellandi* (Horsfield)**

*Definition.*—The species *Tamiops mccllellandi* is constituted by subspecies *mccllellandi*, *collinus*, *kongensis*, *barbei*, *inconstans*, and *leucotis*, and see their synonyms. The species distribution as known from material examined, is shown in Figure 18.

*Diagnosis.*—Species *mccllellandi* is generally smaller and more vividly striped than species *swinhoei* and has shorter, thinner pelage. The inner pair of light stripes is not as bright as the outer pair in *mccllellandi*, and the black middle stripe is not partially bisected longitudinally as is usual in *rodolphei*.

*Relationships to other species.*—The species *mccllellandi* is principally known from west of the Mekong River. Its relationships to the larger, more montane species *swinhoei* are described below in the account of the species *swinhoei*. The geographic relationship of species *mccllellandi* to species *rodolphei* is shown in Figure 18. These two species are ecological equivalents as far as is known. The species *mccllellandi* appears to reach across the Salween and Mekong rivers



FIG. 18. Ranges of the Burmese striped tree squirrel, *Tamiops mccllelandi*, A to F; and the Cambodian striped tree squirrel, *Tamiops rodolphei*, G and H, plotted from collecting localities of material examined. Subspecies of *mccllelandi*: A, *mccllelandi*; B, *collinus*; C, *kongensis*; D, *barbei*; E, *leucotis*; and F, *inconstans*. Subspecies of *rodolphei*: G, *rodolphei*; and H, *elbeli*.

and through Yunnan to northern Vietnam (where it is represented by the subspecies *inconstans*). There it seems to be sympatric with, or interdigitated with, species *maritimus*.

*Intraspecific variation.*—The species *mccllellandi* occurs in forests from Sikkim, Bhutan, Assam, and northernmost Burma southward in forested hill country probably throughout Burma, Thailand excepting the Mekong plain, and the Malay States. Its outer pair of light stripes in the dorsal pelage is strikingly light and prominent in comparison to the subdued inner pair, and it is characteristic that the outer light stripes continue strongly marked across the shoulder area and connect with the light facial stripe.

While five subspecies of *mccllellandi* receive recognition here, the authors wish to point out that there is a greater distinction between the form *mccllellandi* and the other four than there is between any two of the other four. Because of this, one of the present authors (Tate) elected to recognize *mccllellandi* as a monotypic species and the other four forms as constituting the species *barbei*. This may prove to be correct if study of further material discloses no intergradation between *mccllellandi* and *collinus*. One might suppose it to be equally logical in our present state of knowledge, however, to consider the distinction between *mccllellandi* and the other four forms as of subspecific value and that the "other four forms" constitute a variable but single subspecies. From the material that we have studied, it seems to us that *leucotis*, *barbei*, and *kongensis* are distinct geographic subspecies occupying equally distinct physiographic areas. The other form, *collinus*, is somewhat less distinct, and also the considerable geographic area it occupies does not appear to be physiographically distinct. However, this form is more than a broad zone of intergradation between *mccllellandi* and *kongensis*, for it possesses a color character shared by neither, the blackness of the inner paired dark lines. It is here considered, therefore, that the distinction between subspecies *mccllellandi* and the other four is at an advanced subspecific (and perhaps incipient species) state of differentiation; whereas the distinctions between any adjacent two of the subspecies *collinus*, *kongensis*, *barbei*, and *leucotis* are at a subspecies, but less advanced, state of differentiation.

### **Tamias mccllellandi mccllellandi** (Horsfield)

*Sciurus mccllellandi* Horsfield, 1839, Proc. Zool. Soc. London, 1839, p. 152.

*Sciurus pembertoni* Blyth, 1842, J. Asiatic Soc. Bengal, 11, p. 887.

*Sciurus maccllellandi manipurensis* Bonhote, 1900, Ann. Mag. Nat. Hist. (ser. 7), 5, p. 51.



*Types*.—*Sciurus maclellandi*, two cotypes, BM Nos. 79.11.21.372–373, adult male and a young adult, the former marked “lectoparatype,” both from “Assam”; *pembertonii*, BM No. 79.11.21.374, adult female, from Bhotan; *manipurensis*, BM No. 85.8.1.273, old male from Aimole, Manipur.

*Material examined*, from Assam, India.—Tura, Garo Hills (AMNH), one; Tura Mt., Garo Hills (CNHM), three; Pynursla, Khasi Hills (CNHM), two; Mawphlang, Khasi Hills (CNHM), three; Cherrapunji (CNHM), one; Sangau, Lushai Hills (CNHM), three; Karong, Manipur (CNHM), six; Takubama, Naga Hills (CNHM), four; Kohima, Naga Hills (CNHM), two; Sadiya, Mishmi Hills (AMNH), three, (CNHM), one; Dreyi, Mishmi Hills (AMNH), one; Tezu, Mishmi Hills (AMNH), five.

*Material examined*, from Sikkim, India.—Darjeeling (CNHM), one; Rungbong Valley, 4000 feet (MCZ), one; Chungtang (CNHM), three, (USNM), one; Lingtam (USNM), three, (CNHM), 28; “Sikkim” (MNHN), one.

*Material examined*, from Burma.—6 to 25 miles N. of Myitkyina (USNM), five; 170 miles N. of Myitkyina (CNHM), one; Seniku-Shingaw Road (AMNH), one; Laukhaung-Pyepat Road (AMNH), one; Nanyaseik (AMNH), three; Lonkin (AMNH), one; Mansum (AMNH), one; Dalu (AMNH), four; Tagahka (AMNH), five; Luckchanga (AMNH), one; Dagung Hka (AMNH), one; Haibum (AMNH), three; Singkaling Hkamti (AMNH), one; Kawai, W. Bank (AMNH), one; Kaunghein (AMNH), four; Nonswa (AMNH), one; Mawlaik (AMNH), one; Mt. Victoria, Pakokku Chin Hills (AMNH), nine.

*Type description*.—Typically *maclellandi*, studied in 1951, has the median black line about 4 mm. wide and extending from nape to rump. The lateral pair of dark lines extends from the shoulders to the rump but are a little wider, 5 mm. They are partly obscured at their inner edges by the overlying yellowish buffy hair tips of the intervening area. Laterally they are edged by the pair of strongly colored yellow-buff lines which are the primary elements in the dorsal pattern. Then two yellow lines reach from the rostrum over the whiskerpatch, beneath the eyes and ears, become broadened at the sides of the neck and connect with the outer pair of lines on the back, which finally fade out at the rump. The maximum width of this line is at the side of the neck. External to this pair of yellow lines is the merest suggestion of the outermost pair of dark lines about 1 inch in

length and less than 2 mm. in width. Underparts buffy-tipped (without any trace of red) with the bases of the hairs gray. Hands and feet grayish buff. Tail with bases of the hairs brownish buff, subterminal bands black, tips buffy white. Extreme tip of tail blackish. This is the basic form against which all others must be compared. The length of the head and body is ca. 110 mm., of tail ca. 100 mm., hind foot ca. 28 mm. It is apparently a much smaller *Tamiops* than any member of the species *swinhoei*.

*Discussion.*—While there are slight differences in pelage color which may be locally geographic in expression within this typical subspecies, these are negligible by comparison with the differences between *T. m. mccllellandi* and its nearest conspecific neighbor *T. m. collinus*. A series collected high on Mt. Victoria in Burma is not only lighter in ventral pelage color than typical *mccllellandi* but somewhat larger in size. Nevertheless, these differences would make of it only some sort of a micro-race by comparison with those differentiating *collinus* and *mccllellandi*.

*Habits.*—In a letter of June 10, 1961, Lord Cranbrook contributes the following field notes on this species from his collections on the Adung Valley expedition: "No. 60. The commonest squirrel in the district (Myitkyina—Sumpra Bum). Usually seen high up in tall trees, moving in short rushes and then staying motionless, sometimes head downward, often some minutes at a time. I have never seen one in low bushes, always high up. The tail is usually held straight out [behind] and very seldom 'flicked' or held over the back. Frightened, they freeze flattened out with tail extended." These notes were not included in Cranbrook's account in Kinnear (1934).

Another collector wrote: "This squirrel is found in most of the forests above 5,000 feet. It is common but owing to its power of concealment is generally not very easy to find. It is very nimble and appears to glide rather than walk along the boughs and slender twigs. I observed it in pairs and sometimes in small parties often sharing the tree with *D. lokriah*. It seldom comes to the ground. The call is a quickly repeated 'chick' much harsher in tone than that of *F. pennanti*." (C. A. Crump in Wroughton, 1916a, p. 488.)

### ***Tamiops mccllellandi collinus* Moore**

*Tamiops mccllellandi collinus* Moore, 1958, American Mus. Novitates, no. 1879, p. 1.

*Type.*—AMNH no. 163528, an old male from 800 meters elevation, Maymyo, Burma, collected November 28, 1937, by Gerd Heinrich.

*Material examined*.—Maymyo, 800 meters, Burma (AMNH), 14; Mengting, 1700 feet, Yunnan (AMNH), four; Mu-cheng, 5000 feet, Yunnan (AMNH), two; Nam Ting, Yunnan (MCZ), one; Chiang Saen Kao, Chiang Rai, Thailand (USNM), one; Sawan Mt., Ban Seid, Loey, Thailand (USNM), one; Lomloe Mt., Maeo, Goksatawn, Loey, Thailand (USNM), eight; Vientiane, Laos (USNM), five; Chieng Dao, Thailand (CNHM), one; Doi Chieng Dao, 4000 feet, N. Siam (ANSP), three; Chieng Sen [Chiang Saen], N. Siam (ANSP), one; Don Qua, Laos (ANSP), one.

This subspecies is more strongly striped than *mccllellandi*, less red than *barbei*, darker dorsally than *kongensis*, and much more strongly striped than *inconstans*. It is not in geographic contact with *leucotis*, but is ventrally more orange and less yellow than *leucotis*.

### **Tamiops mccllellandi inconstans (Thomas)**

*Tamiops inconstans* Thomas, 1920, Ann. Mag. Nat. Hist. (ser. 9), 5, p. 306.

*Type*.—BM No. 12.7.25.31, an old male from southern Yunnan (possibly near Mengtsze), collected January 31, 1910, by H. Orii.

*Material examined*.—"Yunnan" (BM), one; "Tonkin" (MCZ), three, (CNHM), one; Bao Ha, Tonkin (CNHM), two; Pakha, Annam [Tonkin] (CNHM), one.

*Original description*.—"This very distinct little squirrel is characterized by its unusually inconspicuous striping above and by the strong yellowish buffy of its lower surface—in fact, it is above one of the dullest and below one of the brightest of the genus." We find the ventral pelage to be Light Salmon Orange where the colored hair tips entirely cover the gray hair bases.

### **Tamiops mccllellandi kongensis (Bonhote)**

*Sciurus mccllellandi kongensis* Bonhote, 1901, Proc. Zool. Soc. London, 1901 p. 55.

*Type*.—BM No. 0.10.7.18, adult female from Raheng, Siam, collected February 7, 1900, by T. H. Lyle.

*Material examined*, all from Thailand.—Chieng Dao [Ban Chiang Dao] (USNM), one, (CNHM), one; Mae Hong Sorn [Ban Muai To] (USNM), two; Doi Hua Mot (USNM), one; Doi Phra Chao [Khao Pha Cho] (USNM), one; Mae Wan River near Doi Saket (MCZ), one; Nan [Muang Nan] (USNM), four; Doi Sutep [Doi Suthep] (AMNH), one; Doi Angka [Doi Ang Ka=Doi Inthanon] (MCZ), six, (USNM), two; Koon Tan [Doi Khun Tan or Sathani Khun Tan]

(USNM), four, (ANSP), two, (NR), three, (CNHM), one; Chum Poo [Sathani Tha Chomphu] (NR), two; Mesarieng [Ban Mae Sariang] (USNM), one; Ta Chang Tai [Tha Chang Tai] (USNM), two; Raheng [Ban Rahaeng] (USNM), five; Chiangmai [Muang Chiang Mai] (ANSP), two, (MCZ), three; "Wung Pratart Farm" Kam Peng Pet Prov. [*Kampheng Phet*] (CNHM), 14; 40 miles E. of Um Pang [Ban Um Phang] (AMNH), one; Pitsanulok (AMNH), one; Pak Tha (NR), one; Pak Koh (NR), one; "Den Chai" (NR), one; Pran [Pran Buri] (USNM), two; Huey Yang, Sriracha [Sathani Huai Yang] (USNM), one; "Muang Qua Yie," *Nakorn Sawan* (USNM), one; "Wat Sytie," *Paknampho*, *Nakorn Sawan* (USNM), one; "Ban End," *Chiangmai* (USNM), one; Pujeg, Pak Tho, Rajburi (USNM), two; Kowjeen, Pak Tho, Rajburi (USNM), one; Tungnockarien, Jombing, Rajburi (USNM), three; Borploy, Kanjanaburi (USNM), two; "Tam bol, Tak tog, Bantak," *Tak* [Ban Rahaeng] (USNM), two; Tra Khanun, Hin Laem, Kanachanaburi (USNM), nine; Ban Klua Klan [Ban Khlua Klang], Prachuap Kiri Khan (USNM), one; Klong Klung [Ban Khlung Khlung], *Kampheng Phet* (USNM), one; "Ban Thoong Cheark, Slog Bartara, Kha Nu," *Kamphengphet* (USNM), two; "Srisawat" (ANSP), two.

In this race the dimensions of the various dorsal lines remain almost exactly as in *barbei*. The chief difference occurs in the overall pallid coloration. There is a general infusion of light gray, instead of the reddish orange wash of *barbei* and the yellow wash in *leucotis*. The pale lines of the back in the present race are very pale buffy yellow, and the underparts are about Ochraceous Buff. This subspecies seems to have differentiated in the rain shadow zone of Thailand, and has a range apparently identical with that of the pale race of *Menetes berdmorei consularis*.

### ***Tamiodontomys maclellandi barbei* (Blyth)**

*Sciurus barbei* Blyth, 1847, J. Asiatic Soc. Bengal, 16, pt. 2, p. 875.

*Type*.—Not seen. From Zami River, Ye Province, 100 miles south of Moulmein, Tenasserim, Burma.

*Material examined*, all from Burma.—Kawkereik, Tenasserim (AMNH), two; Lampha, Tenasserim (AMNH), one; Tavoy (CNHM), one; Tenasserim Town (CNHM), one; Taok Village, Tenasserim (AMNH), two; Zami River, Ye Province, 100 miles south of Moulmein (BM), one.



*Discussion*.—While material from Kawkereik at 175 feet elevation has ventral pelage about Ochraceous-Salmon at the throat and Cinnamon-Rufous or Ferruginous on the remainder of the venter, material from nearby Taok at 1100 feet elevation is much paler ventrally and slightly grayer dorsally so as to be really intermediate between *barbei* and *kongensis*. Like the Taok material, also, is a specimen from neighboring Lampha. Ventral pelage of these is nearest to Capucine Orange. The Kawkereik and Lampha material was collected December 12 and 28 respectively, the Taok January 16. The entire dorsal pelage of the Kawkereik material is infused with reddish which shows as Light Salmon Orange in the outer light dorsal stripes.

*Habits*.—Field observations are offered from southernmost Burma: "Completely arboreal. I have never observed this species actually on the ground. Common around villages on the Tenasserim River but not observed further south. More plentiful in native fruit gardens than in jungle. Weight,  $1\frac{1}{2}$ -2 ozs." (G. C. Shortridge in Wroughton, 1915b, p. 713.)

***Tamioops mccllelandi leucotis* (Temminck) [Extraterritorial]**

*Tamias* [sic] *leucotis* Temminck, 1853, Esquisses Zool. Cote Guiné, p. 252.

*Sciurus novemlineatus* Miller, 1903, Proc. Biol. Soc. Washington, 16, p. 147.

*Types*.—*Tamias leucotis* "Mallaca peninsula" and not seen by the present authors; *novemlineatus*, USNM No. 84403, adult male from Trong, 1500 feet, collected February 19, 1897, by W. L. Abbott.

*Material examined*, from Malay States.—"Selangor" (USNM), two; Ginking B., Selangor (USNM), one; Brinchong Hill, 5500 feet, Cameron Highlands, Pahang (USNM), one; Gunong Mengkuang, 4800 feet, Lebah, Selangor (USNM), one; Telom, 3800 feet, Perak near the Pahang border (USNM), one.

*Material examined*, from peninsular Thailand.—Trong [Trang], 500 feet (USNM), one; Khaw Nom Phu, 2000 feet, Trong [Trang] (USNM), one; Ban Kiriwong (USNM), five; Ban Chit [Ban Nong Chik] (USNM), one.

*Material examined*, from Tenasserim, Burma.—Telok Besar (USNM), three.

*Discussion*.—This subspecies lacks the general reddish infusion in the dorsal pelage displayed by *T. b. barbei*, and the ventral pelage of *leucotis* is much the yellower, being Ochraceous Buff in the yellow-

est instances and a little more orange than that in several others, matching no Ridgway color precisely. Surprisingly the series of three from Trong show strong evidence of intergradation with *barbei* both dorsally and ventrally, the ventral pelage being Apricot Buff on the throat and Orange Cinnamon on the venter. Yet from north of this, 200 miles closer to *barbei* range, at Telok Besar in the southern tip of Burma, the specimens show no dorsal infusion of red, and the ventral pelage is also correct for *leucotis*. Presumably less than 100 miles north of this *leucotis* intergrades with both *barbei* and *kongensis*.

*Habits.*—Concerning the distribution and habits of this subspecies Robinson (in Bonhote, 1903, p. 21) wrote, "This beautiful little species was not met with on the Eastern side of the Peninsula. In Perak and Selangor it is certainly a mountain form, and I do not think it occurs much below 3000'. It was very common at Telom, and was also very abundant on the mountains round the Semangko Pass. It is very largely an insectivorous species, and seems to keep chiefly to the trunk and main branches of the trees, running along them with its tail pressed close against the bark." Chasen (1940, p. x) in commenting on the distinctive mountain fauna encountered above 3000 feet elevation in the Malaysian Subregion, notes that, "A Himalayan element (e.g., *Rattus bowersi*, *Tamiops*, *Dremomys rufigenis*, *Sciurus erythraeus*) is the dominant feature of the high-levels in Perak, Pahang and Selangor, but it fades out in the south, and is absent in Negri Sembilan and on the Johore hills; it is also weak on the isolated summit of Kedah Peak in the north."

### ***Tamiops rodolphei* (Milne-Edwards)**

*Definition.*—The species *rodolphei* is constituted by subspecies *rodolphei* and *elbeli* and the named forms here included in them. Its distribution, shown in Figure 18, is in Cambodia, southern Laos, southern Vietnam, and eastern Thailand.

*Diagnosis.*—Species *rodolphei* is distinguished from the other species of this genus by: (1) The outer and inner pairs of light lines are of equal width. (2) The inner pair of light lines approximates the brightness of the outer pair. (3) The blackish middorsal line is almost invariably divided for part of its length by a very thin, pale brown line.

*Relationships to other species.*—*Tamiops rodolphei* appears to replace *Tamiops mccllellandi* with no known overlap or intergradation in eastern Thailand. In southern Vietnam it overlaps or interdigi-

tates with the known southern extremity of the range of the species *maritimus*. Compare Figures 18 and 20.

### **Tamiops rodolpheii rodolpheii** (Milne-Edwards)

*Sciurus (Tamias) rodolpheii* Milne-Edwards, 1867, *Revue Mag. Zool.*, **19**, p. 227.

*Tamiops maccllellandi liantis* Kloss, 1919, *J. Nat. Hist. Soc. Siam*, **3**, p. 370.

*Tamiops lylei* Thomas, 1920, *Ann. Mag. Nat. Hist. (ser. 9)*, **5**, p. 307 (homonym).

*Tamiops maccllellandi dolphoides* Kloss, 1922, *J. Nat. Hist. Soc. Siam*, **4**, p. 101.

*Callosciurus holti* Ellerman, 1940, *Families and Genera of Living Rodents*, **1**, p. 355 (new name for *lylei*).

*Types*.—*Sciurus (Tamias) rodolpheii* MNHN No. 1864-683 (318), adult from Saigon, Indo-China; *dolphoides*, apparently lost, Kloss field no. 2723/CBK, adult female from Kompong Som Bon, near Sré Umbel, southwest Cambodia; *liantis*, USNM No. 221542, young adult female from Sata Hip, near Cape Liant, southeastern coast of Siam; *lylei*=*holti*, BM No. 6.10.7.9, young adult male from sea coast fifty miles south of Bangkok, Siam.

*Material examined*, from Thailand.—Sriracha [Ban Si Rachal] (USNM), two, (CNHM), one; Chantabun [Chanthaburi] (ANSP), two, (USNM), one; Kao Sabab [Khao Sa Bap] (USNM), two; Lem Ngop [Ban Laem Ngop] (USNM), one; Kao Seming, Krat [Khao Saming, Trat] (ANSP), two, (USNM), one; Nongkhon [Ban Nong Kho] Chon Buri Prov. (USNM), two.

*Material examined*, from Indochina.—Ban Me Thuot [Buon Ma Thuot], Annam (CNHM), four; Bien Hoa, Cochin China (USNM), two; Gougah [Lien Gongah] Annam (CNHM), 11, (MCZ), one; Thateng (USNM), one, (CNHM), 11; Pak-Sé, Laos (CNHM), two; Paksong, Laos (CNHM), one; "Phu Kongtoul" (CNHM), one; Quangtri Phuoc Mon, Annam (CNHM), three; Ninh Hoa, Annam (CNHM), one; "Cochin China" (CNHM), one; Plateau Bolovens, 2500-3000 feet, Laos (ANSP), three, (AMNH), three; Tayninh, 100 feet, Cochin-China (MNHN), one; Angkor, 200 feet, Cambodia (MNHN), two; N. V. Kampot, 100 feet, Cambodia (MNHN), one.

The head and nape are almost uniformly dull brown in this subspecies. The tail is exceptionally slender due to shortness of its hairs. The underparts tend toward yellow or orange, somewhat as in *maccllellandi kongensis* or *m. collinus*, never buffy or whitish as in *m. maccllellandi* and in subspecies of *maritimus*.

***Tamiops rodolphei elbeli* Moore**

*Tamiops rodolphei elbeli* Moore, 1958, Amer. Mus. Novitates, no. 1879, p. 4.

*Type*.—USNM No. 294876, adult female, skin and skull, collected by Robert E. Elbel on January 18, 1952, at village of Ban Lad, Pookeio District, Chaiyaphum Province, Thailand (ca. latitude 16° 40' N., longitude 101° 45' E.).

*Material examined*.—Ban Lad, Pookeio, Chaiyaphum, Thailand (USNM), two; Ban Non Toulek, Pookeio, Chaiyaphum, Thailand (USNM), three; Khon Kaen, Thailand (USNM), seven; "Watpa" (ANSP), one.

*Diagnosis*.—*Tamiops rodolphei elbeli* is distinguished from all subspecies of *Tamiops mccllellandi*, *swinhoei*, or *maritimus* by the mid-dorsal black stripe, for this stripe is divided at least part of its length by a fine line of yellowish brown down its middle. It differs from *Tamiops rodolphei rodolphei*, which occurs to the east and south of it, in the brilliance of its Isabella Color crown and nape compared with the Buffy Brown (XL) to Snuff Brown (XXIX) crown and nape of *T. r. rodolphei* (including three virtual topotypes from Bien Hoa, Cochinchina).

*Dimensions*.—The skull measurements (in millimeters) of the type are: occipitonasal length, 32.6; condylobasal length, 30.0; right maxillary toothrow, 5.4; palatal length, 15.8; mastoid breadth, 14.9; greatest breadth, 20.1; nasal length, 10.2; and orbitonasal length, 13.6.

Field measurements in millimeters of the total length, tail length, and hind foot of the type of *T. r. elbeli* are, respectively, 250, 130, and 30. The same characters recorded for a male and two females of *T. r. elbeli* from Ban Non Toulek are, respectively: 220, 250, 220; 110, 129, 102; and 30, 32, 30.

*Variation*.—Of 17 skulls of *Tamiops m. collinus* and *kongensis* examined in the United States National Museum from localities geographically near to *elbeli*, five have the posterior surface of the extremities of the upper incisors beveled so that it shows just a slight concavity in the side view. Each of the other 12 is cut so that it shows a notch. Of 13 skulls of *T. r. elbeli* examined, four have just a slight concavity, and nine have a straight bevel. The lateral margins of the basioccipital are curled ventrad and rise slightly to a low point or process in *T. r. elbeli*, but in *T. m. collinus* and *kongensis* and also *T. r. rodolphei* these edges remain low ridges and do not form a point or process.



*Discussion.*—This subspecies comes from the eastern part of Thailand, the Mekong plateau 2000 feet in elevation, which is subtended on the north and east by the Mekong River and south by the Phanom Dang Raek, a range of mountains. Excepting for Gyldenstolpe (1914) who collected mammals on its southwestern edge about Korat, evidently no mammalogist had collected on this plateau before R. E. Elbel got into the northwestern quarter of it. The material representing *Tamiops r. elbeli* all comes from Chaiyaphum Province and Khonkaen Province.

### ***Tamiops swinhoei* (Milne-Edwards)**

*Definition.*—This species includes subspecies *swinhoei* and the several named forms here included in it, and subspecies *vestitus*. Figure 19 shows the distribution of species *swinhoei* as known to us from specimens.

*Diagnosis.*—This is apparently an extremely variable species geographically, and although *swinhoei* seems to be generally larger than the other species of *Tamiops* and to have longer, denser fur, diagnostic distinction by these characters does not seem possible in the material we have examined. These two tendencies may be related to the fact that species *swinhoei* lives farther north or at higher elevations than the other species of *Tamiops*. The outer pair of light lines is less brilliant than those of *mcclellandi* and often broader, and they more generally stop at the shoulder instead of being connected with the cheek stripe.

*Relationships to other species.*—The range of this species apparently does not overlap that of *mcclellandi* to any great extent. The only localities from which both species have been taken are where the edges of their ranges meet. At these places there has been a notable difference in the elevations at which the two species were taken. In northeastern Burma near Imaw Bum Anthony (1941, p. 93) took the species *mcclellandi* between 1000 and 2000 feet elevation in definitely tropical habitat and at 4500 feet, but he collected the species *swinhoei* at 9000 and 10,000 feet. Northward about 130 miles from Imaw Bum, Cranbrook collected *mcclellandi* at 1500 feet elevation but at nearby Adung Valley took *swinhoei* at 8000 and 9000 feet. At Mucheng, Yunnan, China, about 175 miles south of Imaw Bum, Edmund Heller collected the species *mcclellandi* at 5000 feet elevation and *swinhoei* at 7000 feet. These three localities are the westernmost known for the species *swinhoei* and the northeasternmost known for *mcclellandi*. See Figure 19.



FIG. 19. Distribution of the Chinese striped tree squirrel, *Tamiops swinhoei* (entire range) and the maritime striped tree squirrel, *Tamiops maritimus* (north-eastern range) as obtained from plotting collecting localities of materials examined. Subspecies of *swinhoei*: A, *swinhoei*; and B, *vestitus*. Subspecies of *maritimus*: C, *maritimus*; and D, *monticolus*.

On the apparent southern edge of the range of *T. swinhoei* Delacour and Lowe evidently obtained a series of 17 from 8000 to 10,000 feet elevation on Mt. Fan Si Pan near Chapa in northern Tonkin, but at lower elevations in the same vicinity took *T. maritimus hainanus*. In reporting this, Osgood (1932, p. 292) recognized these examples of *swinhoei* as a race of *monticolus*. Eastward in the range of *swinhoei* there is an extraordinary gap in examined material of this species, as shown on the map. The eastern distribution (*T. s. vestitus*) lies entirely in Wang's (1956) oak-dominated deciduous broad-leaved forest type. The area of this forest type extends westwardly about to the western distribution (*T. s. swinhoei*), but it appears that not a single one of the twenty-odd localities that we have for *T. swinhoei* here is in that general forest type area. Possibly this constitutes

something of a barrier, and the absence of records of *Tamiops* from middle China really indicates absence of the genus, for *Sciurotamias* has been collected there. Compare Figures 19 and 33. Of course, *Sciurotamias* is very much a ground squirrel and would possibly have increased in the same places where *Tamiops* may have been eliminated by deforestation. Fu (1936) found "*Tamiops macclellandi vestitus*" in the Sung-shan, which he describes as a famous mountain in western Honan with luxuriant forests, and he says that this squirrel lives in holes in trees. Other than this we find no literature references to *Tamiops swinhoei* in very central China.

### ***Tamiops swinhoei swinhoei* (Milne-Edwards)**

*Sciurus macclellandi* var. *swinhoei* Milne-Edwards, 1874, Recherches . . . des mammifères, 1, p. 308.

*Tamiops clarkei* Thomas, 1920, Ann. Mag. Nat. Hist. (ser. 9), 5, p. 304.

*Tamiops maritimus forresti* Thomas, 1920, Ann. Mag. Nat. Hist. (ser. 9), 5, p. 305.

*Tamiops spencei* Thomas, 1921, J. Bombay Nat. Hist. Soc., 27, p. 503.

*Tamiops macclellandi russeolus* Jacobi, 1923, Abh. Berich. Mus. Dresden, 16, no. 1, p. 11.

*Tamiops monticolus olivaceus* Osgood, 1932, Field Mus. Nat. Hist. Publ., Zool. Ser., 18, p. 292.

*Types*.—*Sciurus macclellandi* var. *swinhoei*, type not found in the MNHN in Paris, but there are four possible cotypes taken at Moupin by Pere David in 1870, MNHN 1870-608 (309); 1870-39 (311); 1870-38; and 1870-40 (308); *russeolus*, three cotypes (skins without skulls) from Tsalila, a pass near Atuntse, between the upper Yangtse and upper Mekong Rivers, SMTB 5887-9 collected September, 1916-1917 [1914] by Hugo Weigold; *clarkei*, BM No. 20.1.16.6, adult male from forests in Yangtse Valley, latitude 27° 20' north, 8000 feet collected September, 1918, by George Forrest; *forresti*, BM No. 20.1.16.4, adult male from Lichiang Range, Yunnan, 27° 20' latitude north, 11,000 feet collected July, 1918 by George Forrest; *spencei*, BM No. 20.8.8.6, female from 28° 22' north latitude, 97° 40' east longitude, at 10,000 feet; *olivaceus*, BM No. 32.4.19.6, adult male from Lo Gui Ho, Tonkin, 5000 feet, collected December 30, 1916 by P. M. Leonard.

*Material examined*, from Tibet.—Tsarong, 7000 feet, Londjre Valley (USNM), one.

*Material examined*, from Sikang, China.—Mupin [Muping] (MNHN), one, (USNM), two; Luting Shan [Lutingkiao] (CNHM),

one; Wuchi [Wushi] (CNHM), one; Kulu (CNHM), one; "Ta Chiao," 12,000 feet near *Tatsienlu* (MCZ), one; 35 miles east of Hokow (ANSP), one; Madischung Valley, 10 miles from Hokow (ANSP), one.

*Material examined*, from Kansu, China.—Chulungapu, 8000 feet, Upper Tebbuland (CNHM), one, (MCZ), six.

*Material examined*, from Szechwan, China.—"Lian-feng-Kiang," *Omei Shan* (CNHM), one; 25 miles west of Wenchwan, 5-9000 feet (AMNH), nine, (USNM), three; Wa Shan (USNM), one; Weichow [Weikiu] (USNM), one; "Tsungshi (Ngoloshi)" (ANSP), one, (MCZ), one.

*Material examined*, from Burma.—Adung Valley, 8-9000 feet, Kachin Prov. (CNHM), three; Imaw Bum (AMNH), two; Road to Chimeli Pass, 10,000 feet (AMNH), two.

*Material examined*, from Yunnan, China.—"Mt. Djinaloko," Yangtze Valley slopes, 10,000 feet (USNM), one; "Hofuping Mts.," Mekong Valley (USNM), eight; "Sila Mts.," Salween-Mekong Divide, 8000 feet (USNM), one; N. slopes of Likiang Snow Range (USNM), one; Likiang, 10,000 feet (AMNH), three; 40 miles N. of Likiang (MCZ), one; "Tao Mung Chung" southwest of *Lu-tien* (MCZ), one; Mu Cheng, 7000 feet (AMNH), three, (MCZ), one; Ngu-luko (CNHM), one; "Yunnan" (CNHM), two.

*Material examined*, from Indochina.—Lo-Gui-Ho, Tonkin (CNHM), three; Chapa, Tonkin (CNHM), five.

*Pelage color*.—Compared with *mccllellandi*, *T. s. swinhoei* is often distinguished by its much larger size and long, soft pelage. The general dorsal color is yellowish brown. The black middorsal line is much wider than in *mccllellandi*, 9 to 10 mm. The width of the pair of black lateral lines is ca. 7 mm., and their length ca. 75 mm. The outer light line is in *swinhoei* dull yellow brown (scarcely brighter than the yellow brown lines on either side of the median line). This line is interrupted at the shoulder, not connecting with the cheek line which extends from beneath the ear forward to the whisker patch. The outermost dorsal line is black. Its dimensions are about 28 by 5 mm. The underparts are buffy white with the bases of the hairs slate gray.

*Discussion*.—A circle only 100 miles in radius will include the type localities of *russeolus*, *clarkei*, *forresti*, and *spencei*, and one of 150 miles radius will include the type localities of these four and that of *swinhoei* as well. These localities are on high elevations in the



mountains segregated by the deep, north-south river gorges which dissect the general area. Two of the type localities, furthermore, those of *russeolus* and *forresti*, are not even so separated from each other. We cannot concur in G. M. Allen's (1940, p. 669) acceptance of *clarkei* as a good subspecies. His distribution map does not include in the range of *T. s. swinhoei* the Yunnan locality of Mucheng, nor in the range of *clarkei* the Yunnan locality of Taomungchung southwest of Lutien, although he identified material from these places respectively as *T. s. swinhoei* and *T. s. clarkei*. The inclusion of Mucheng brings the range of *swinhoei* 300 miles farther south than he had it shown, and the inclusion of Taomungchung southwest of Lutien would extend his shown range of *clarkei* nearly 200 miles east. The specimen from Taomungchung seems to us as different from Likiang material as either is from a series of *swinhoei* from near Wenchwan, and that if it were represented by a series, it would have as good a claim on subspecific difference from typical *swinhoei* as does the material from Likiang. Another subspecific name for one specimen from one locality could be justifiably added to the list of synonyms by the next author, however, unless some further collecting is done in the range of this species to demonstrate the geographic relationships of this and some of the other considerable variation which is already represented by names in the presently available material.

*Habits*.—In a letter of June 10, 1961 Lord Cranbrook contributed the following observations on this species from his field notes of 30 years earlier in the Adung Valley of Burma: "No. 206. Shot in a tree amongst scrub jungle just below snow line (March). When first seen quite low down in bushes and low tree rhododendrons, very unlike the habits of the striped squirrels [*T. maclellandi*] seen further south, which keep entirely to high trees. Tail held straight out behind, not flicked. No. 229. Shot running along a fence around a field." For other details see Cranbrook's account of the expedition in Kinnear (1934).

### ***Tamiops swinhoei vestitus* (Miller)**

*Tamiops vestitus* Miller, 1915, Proc. Biol. Soc. Washington, 28, p. 115.

*Type*.—USNM No. 199561, adult male from Hsin-lung-shan, 65 miles northeast of Peking, collected February 15, 1915, by Arthur de Carle Sowerby.

*Material examined*, all from Chihli [Anhwei] Province, China.—Tungling (AMNH), six, (CNHM), six, (MCZ), one; Eastern Tombs

(AMNH), six, (MCZ), two; Hsing-lung-shan, 65 miles N.E. of Peking (USNM), 12; 80 miles E. of Peking (USNM), two.

*Pelage color.*—This race seems to be a pallid offshoot of the mountain dwelling subspecies *swinhoei*. As is also found in *Tamiops maritimus* of southern China, there is a striking difference between summer and winter pelage. This is exhibited, for example, by seven specimens taken in April while still in the winter pelage in which only the midstripe is black, and five specimens taken in late July and early August in the summer pelage which differs by the midstripe and inner dark pair of stripes all being black. The outer and inner pairs of light lines are whitish, the outer pair whiter than the inner. The underparts are buffy white, their hair bases gray.

*Discussion.*—Jentink (1883) records two specimens of this subspecies in the Leiden Museum from Tingchow, which is apparently 120 miles southwest of Peiping. It is also this form which Fu (1936) reported in the Sung Shan of western Honan.

### ***Tamiops maritimus* (Bonhote)**

*Definition.*—This evident species includes subspecies *maritimus*, *monticolus*, *hainanus*, and *moi*, and see the synonyms of these. The known distributions of *maritimus* and *monticolus* are shown in Figure 19, those of *hainanus* and *moi* in Figure 20.

*Diagnosis.*—The pelage is comparatively short and thin, the general coloration tends to be more olive, and the inner pair of light stripes tends to be nearer the color of the nape, than in the other species of *Tamiops*.

*Relationships to other species.*—This is a relatively low altitude species occupying the southeastern coastal region of China and all of Vietnam and Laos, and according to G. M. Allen (1940) apparently penetrating to middle China. At the southern end of its range it ascends the Langbian Peaks to considerable elevation, but it is evidently also found at the foot. At Pak Hin Bun, Laos, Robinson found it along the Mekong River and on islands in the River. Although we have examined specimens of it from two other Laos localities along the Mekong, Vientiane and the westernmost locality, Lo Tiao, it is not known from west of that river. Its geographic relationships to *Tamiops swinhoei* east of the Mekong in China remain too much a mystery. It is at least of interest that Thomas (1920, p. 305) once thought that *maritimus* penetrated Yunnan to the Likiang Range. When it is discovered what the distributions of these striped squirrel species are in central and southern Yunnan, it should

become possible to interpret with greater confidence the information already available from northern Yunnan and nearby Burma, Sikang, and Szechwan.



FIG. 20. Southern part of distribution of the maritime striped tree squirrel species, *Tamiops maritimus*, as determined by plotting collecting localities of material examined. Subspecies: A, *maritimus*; B, *monticolus*; C, *hainanus*; and D, *moi*.

### ***Tamiops maritimus maritimus* (Bonhote)**

*Sciurus maclellandi maritimus* Bonhote, 1900, Ann. Mag. Nat. Hist. (ser. 7), 5, p. 51.

*Sciurus maclellandi formosanus* Bonhote, 1900, Ann. Mag. Nat. Hist. (ser. 7), 5, p. 52.

*Tamiops sauteri* J. A. Allen, 1911, Bull. Amer. Mus. Nat. Hist., 30, p. 339.





from the practice of citing and mapping localities only of material examined, and are including here and mapping the additional records reported by G. M. Allen (1940, pt. 2, p. 684):

*Material examined*, from Fukien.—Pucheng (BM), two; Kuaton [Kaotien] (BM), eight; Chungfengling [Chingfengling] (BM), eight; Kienyang (BM), one; Tingchow (BM), two.

*Material examined*, from Anhwei.—Chinteh [Tsingteh] (BM), 10.

*Material examined*, from Hupeh.—Changyang (BM), one.

*Material examined*, from Chekiang.—Ningpo (BM), one.

*Original description*.—"Brighter than [*maritimus*] to which it is most nearly allied, and from which it differs in having the median dorsal stripe more distinct and always continued to the root of the tail. The outermost light stripes are very broad and distinct and continued to the root of the tail."

*Discussion*.—We find contrary to G. M. Allen (1940, pt. 2, p. 684) that Bonhote was right in differentiating between the coastal samples of this species and those inland in the mountains. However, he did err in trying to distinguish them primarily upon a character of the middorsal stripe. The better character which he merely mentions is that the outer pair of dorsal light stripes continues posteriorly to the base of the tail and are broader and more distinct throughout than in *maritimus*. Bearing in mind, of course, the pelage differences related to season, we note that in the summer *monticolus* material from the mountains about Chunganhhsien, the dark stripes are generally blacker than in the winter material from there; although there is also one taken on December 9 from the mountains near Yenping, on which the dark stripes are quite as black as any with summer dates. Comparing only winter series, six January and three March *maritimus* specimens from Fuchinghsien with five December, one January, two February, and one March *monticolus* ones from near Yenping, we find the two series easily distinguished from each other. Eight of the nine Yenping ones in winter pelage are individually distinguished when mingled in a series of *maritimus*. The ten *maritimus* from Fuchinghsien and three from Yuki in winter pelage remain equally distinguishable when placed in the series of eight Yenping *monticolus*. The Yenping material in winter pelage is also consistently redder in the dark stripes and its inside light stripes are lighter and buffier than the nape whereas those of the Fuchinghsien material are the olive gray of the nape. These latter characters are not displayed by the four Chunganhhsien winter pelage examples of *monticolus*, however. This may be a formerly more distinct northern

subspecies of *maritimus* in the process of being obliterated, or our material may be from a zone of intergradation between the two good subspecies.

*Tamiodon maritimus monticolus* appears to occur in an area which coincides rather well with the extent in eastern China of two of Chi-Wu Wang's (1956) general vegetation types: 1. Evergreen broad-leaved forest of evergreen oaks, schima and laurels, with *Pinus massoniana* in secondary stands. 2. Mixed mesophytic forest.

*Dimensions*.—In six *maritimus* from 500 feet elevation 70 miles southwest of Yenping, Fukien, taken in November and December of 1921, and four *monticolus* taken in April of 1922 at 2000 feet elevation near Yenping, all by Arthur de Carle Sowerby, hind foot and head-and-body size show no differentiation, but five of the *maritimus* have tails recorded between 120 and 125 mm., whereas the longest three of the *monticolus* range from 110 to 117 mm.

### ***Tamiodon maritimus hainanus* (J. A. Allen)**

*Tamiodon macclellandi hainanus* J. A. Allen, 1906, Bull. Amer. Mus. Nat. Hist., 22, p. 476.

*Tamiodon macclellandi riudoni* J. A. Allen, 1906, Bull. Amer. Mus. Nat. Hist., 22, p. 477.

*Tamiodon macclellandi laotum* Robinson and Kloss, 1922, Ann. Mag. Nat. Hist. (ser. 9), 9, p. 92.

*Types*.—*Tamiodon m. hainanus*, AMNH No. 26664, an adult female from Lei Mui Mon, mountains of Hainan Island, China, collected December 31, 1902, by agents of Alan Owston; *riudoni*, AMNH No. 26672, an adult male from Riudon, lowlands of Hainan Island, China, collected March 5, 1903, by agents of Alan Owston; *laotum*, BM No. 26.11.17.6, adult male from Pak Hin Bun, Mekong River, Laos, collected March 2, 1920, by Herbert C. Robinson.

*Material examined*, from Hainan, China.—Nodoa (AMNH), 57, (CNHM), 14, (MCZ), six, (USNM), one; Nam Phong (AMNH), 10, (CNHM), four, (USNM), one; Riudon (AMNH), two; Lei Mui Mon (AMNH), nine, (USNM), two; Kachek (USNM), one.

*Material examined*, from Tonkin, Vietnam.—Pakha [Pa Kha] (CNHM), one; Muong Boum (CNHM), six; Lieng San [Leng Sang] (CNHM), five; Nong Lum (CNHM), three; Chapa [Cha Pa] (CNHM), seven, (USNM), two, (MCZ), one; Phong Tho (CNHM), one; Muong Mo (CNHM), seven, (USNM), one, (MCZ), one; Ba Nam Chi (CNHM), one; Lai Chau (CNHM), two, (USNM), two, (AMNH), one; Muong Moun (CNHM), five, (AMNH), two; Pa

Ham (CNHM), two; Bac Tan Tray (AMNH), one, (ANSP), one; Moung Mouen (ANSP), two.

*Material examined*, from Annam, Vietnam.—Hoi Xuan (CNHM), four.

*Material examined*, from Laos.—Lao Fou Tchay (CNHM), one; Phong Saly (CNHM), five; Muong Yo (CNHM), five; Boun Tai [Bun Tai] (CNHM), one; Lo Tiao (MCZ), two; Xieng Khouang (AMNH), two, (MCZ), three; Tha Ng'on, Vientiane (CNHM), one; Saravane (CNHM), one; Phu Kobo (MCZ), three; Col de Taloun (MCZ), two; "Indochina" (CNHM), one.

The extensive series in winter pelage now available from Hainan and Tonkin show no color difference from the winter pelage material of *maritimus*, but as G. M. Allen (1925, p. 7) pointed out and Osgood (1932, p. 290) amplified, there is a size difference. Hind feet in *maritimus* measure about 32 to 35 mm. in the dried skins, and those of *hainanus* measure about 28 to 30 mm. in the dried condition. The skulls of *maritimus* are also larger. No other examples of the reddish *riudoni* have appeared to justify the supposition that this represents a lowland race, and the type apparently is a strongly erythristic individual.

Robinson and Kloss (1922) attributed no diagnostic characters to their *laotum*, and although Osgood (1932, p. 291) retained it as "well characterized by very pale color which reaches its extreme development in southern Laos," he had only one specimen from southern Laos.

### ***Tamiops maritimus moi* (Robinson and Kloss)**

*Tamiops macclellandi moi* Robinson and Kloss, 1922, Ann. Mag. Nat. Hist. (ser. 9), 9, p. 92.

*Type*.—BM No. 26.11.17.7, adult male from Langbian Peaks, 5500 to 6500 feet, southern Annam, collected April 25, 1918, by C. Boden Kloss.

*Material examined*, all from southern Vietnam.—Pie de Langbian (MCZ), four; Langbian Peak (MCZ), two, (CNHM), 10; Dalat (CNHM), one; Gougah (MCZ), one, (CNHM), two.

*Original description*.—"Like *T. m. laotum*, but darker above; upper parts more suffused with ferruginous, so that in addition to being more rich-coloured generally, the yellow stripes are ochraceous instead of buff, while the rump and the outer pair of dorsal stripes are a brighter brown."

*Discussion.*—This is only a faintly distinguishable subspecies. The winter pelage is like that of *hainanus* excepting for the two dark paired dorsal stripes being faintly redder. We find that the hind foot of *moi* is larger than that of *hainanus*, however, in the seven MCZ specimens, which range between 31 and 32.2 mm. in the dried skins. The skull does not appear to be appreciably larger than that of *hainanus*.





## PLAIN LONG-NOSED SQUIRRELS

### Genus **DREMOMYS** Heude

*Dremomys* Heude, 1898, Mem. Hist. Nat. Emp. Chinois, 4, part 2, p. 54.

*Zetis* Thomas, 1908, J. Bombay Nat. Hist. Soc., 18, p. 244.

*Type species*.—*Dremomys*, *Sciurus pernyi* Milne-Edwards; *Zetis*, *Sciurus rufigenis* Blanford.

*Definition*.—The genus *Dremomys* consists of four species of the Indochinese Subregion, *lokriah*, *pernyi*, *rufigenis*, and *pyrrhomerus*, and one species of the Malaysian Subregion, *everetti*. See Figure 21.

*Diagnosis*.—The genus *Dremomys* possesses the following characteristics: (1) There is one bony septum crossing the chamber of the auditory bulla. (2) The teeth are orthodont or slightly proödont. (3) The length of the nasal bone exceeds the least interorbital breadth. (4) The upper cheek teeth are not specialized with an extremely deep valley that remains as a dirt-filled lake after the cusps have been planed away by use. (5) The coronoid process of the mandible is well developed and strongly falcate. (6) The baculum is composed of two separate parts, shaft and blade. (7) The dorsal pelage has no longitudinal light stripes.

The genus *Dremomys* may be distinguished from other genera of Sciurinae of the Indian and Indochinese subregions by the above characteristics as follows: from *Ratufa* by 1, 2, 3, and 6; *Funambulus* by 5, 6, and 7; *Callosciurus* by 3; *Tamios* by 3 and 7; *Menetes* by 4, 5, and 7; and *Sciurotamias* by 1 and 2.

*Systematic history*.—*Dremomys* was poorly characterized by Heude. Thomas (1908) discussed the genus under the name *Zetis* in greater detail, and gave a key to the species (pp. 248–249). Later Thomas (1916a) published another synoptic key using the generic name *Dremomys*. Pocock (1923) and Ellerman (1940) gave the genus full standing, and Archbold and Tate (1935, p. 1, footnote 1) designated *Dremomys pernyi* as the genotype. Besides the species *pernyi*, Heude included three other species in the genus which he described as new: *saltitans*, *collaris* and *latro*. The animals to which these three names were applied, however, have since been placed in the genus *Sciuro-*

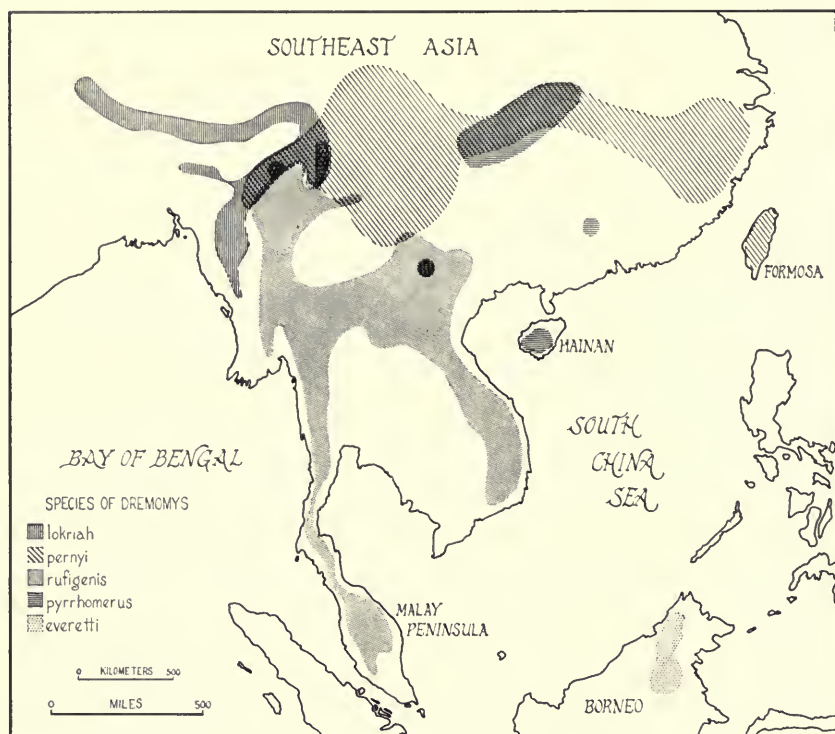


FIG. 21. Composite, slightly generalized distribution of the five species of the long-nosed squirrel genus *Dremomys*.

*tamias* (G. M. Allen, 1940, p. 646). It was recognized in the early nineteen hundreds that *Dremomys* was the proper genus for the species *lokriah* and *rufigenis*, and various authors have at one time or another (correctly) placed the species *everetti* and *pyrrhomerus* in this genus. These four species and the original one *pernyi* constitute the genus *Dremomys*.

*Range*.—On the continent it is a wide-ranging genus, extending from Nepal in the Himalayas 2000 miles east across the breadth of China to the coastal province of Chekiang, and from only 250 miles above the equator in the Malay Peninsula north through Siam, Burma, Indochina and China nearly 2000 miles to northern Szechwan. It occurs also on Borneo, Hainan, and Formosa.

*Dremomys* is a long-nosed squirrel, characteristically with plain, drab dorsal pelage. It is generally reported to be terrestrial or semi-terrestrial in habit, and to occur only in the mountains or hills where

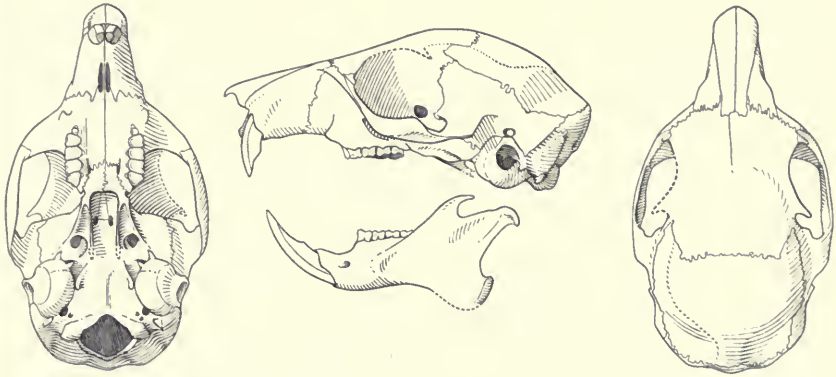


FIG. 22. Skull and left mandible of the Himalayan long-nosed squirrel, *Dremomys lokriah*, AMNH No. 114936,  $\times 1$ .

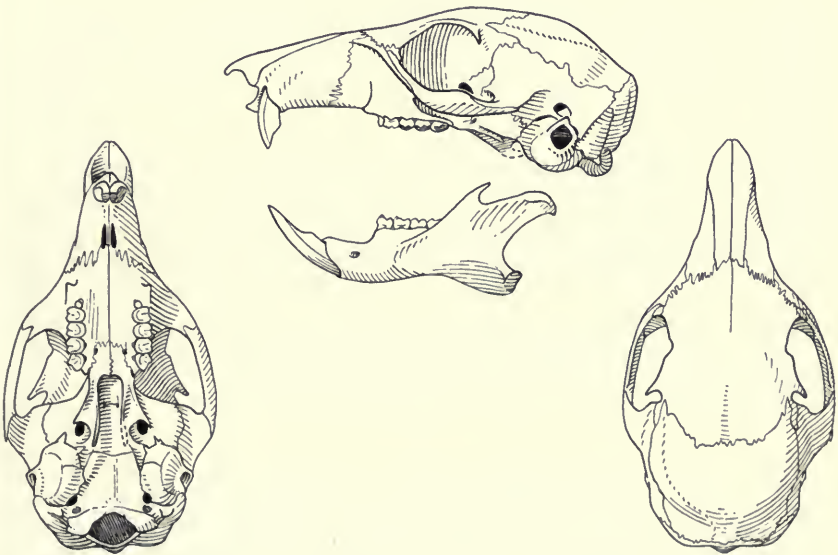


FIG. 23. Skull and left mandible  $\times 1$  of the Chinese long-nosed squirrel, *Dremomys pernyi*, AMNH No. 43999, but lower jaw of AMNH No. 114938.



TABLE 13. Dimensions of Some Type Specimens of the Genus *Dremomys* (Nos. 1 to 4 are placed in species *lokriah*, nos. 5-12 in *pernyi*, 13-17 in *rufigenus*, 18-20 in *pyrrhomerus*, 21 in *everetti*.)

NAME	BODY			SKULL						
	Head & Body	Tail	Hind Foot	Total Length	Mas-toid Breadth	Nasal Length	Dia-stena	Length Palate	Length Bulla	Maxillary Tooth-row
1. <i>lokriah</i>	195 ±	140 ±	46	....	20.5	....	11.5	23.7	7.5	7.3
2. <i>bhotia</i>	171	134	47	50.0	20.4	15.4	12.2	24.8	8.2	7.7
3. <i>garonum</i>	190	153	48	50.4	19.6	16.1	11.3	24.9	8.2	8.4
4. <i>macmillani</i> <sup>1</sup>	180	156	48.5	50.6	21.0	15.0	11.8	24.7	8.7	8.3
5. <i>griselda</i>	201	144	48	50.6	....	16.7	12.2	24.9	9.0	8.0
6. <i>lichtiensis</i>	170 ±	160 ±	51	49.2	18.7	15.9	11.3	24.6	9.0	7.9
7. <i>howelli</i>	199	138	48	53.6	20.0	17.6	12.6	26.7	8.5	8.0
8. <i>mentosus</i>	184	111	45	50.6	19.2	16.7	11.8	....	8.2	7.8
9. <i>imus</i>	203	159	54	57.0	20.8	18.9	14.2	28.0	9.0	8.2
10. <i>senex</i>	202	171	46	53.0	20.7	17.6	12.4	26.8	9.5	8.9
11. <i>calidior</i>	230 ±	145 ±	49	....	20.2	16.8	12.5	26.0	8.8	8.1
12. <i>ovstoni</i>	220 ±	150 ±	50	....	21.5	18.6	13.5	27.7	9.4	8.7
13. <i>laomache</i>	168	148	51	54.7	22.0	18.0	11.8	27.1	8.9	10.1
14. <i>ornatus</i>	186	147	50	56.8	21.8	20.5	13.3	28.6	8.5	9.8
15. <i>fuscus</i>	190 ±	140 ±	50	53.5	21.0	17.5	12.5	26.4	8.2	9.1
16. <i>belfieldi</i>	203	143	50	54.7	21.5	19.5	12.5	27.1	7.9	9.3
17. <i>optimus</i>	210	174	51	53.3	21.7	17.3	12.1	27.3	9.3	9.8
18. <i>pyrrhomerus</i>	215 ±	120 ±	54	57.6	21.7	20.1	14.3	29.5	9.8	9.4
19. <i>riudonensis</i>	165	155	48 ±	....	21.5	18.4	12.6	26.4	9.0	9.0
20. <i>gularis</i>	220	168	52	57.5	22.6	19.1	13.0	27.4	8.5	9.4
21. <i>everetti</i>	160 ±	115 ±	45	....	18.5	16.3	12.0	24.2	7.5 ±	8.0

<sup>1</sup> Nos. 4-6 are young adults.

there is some forest. Its species all have a small, rather inconspicuous, whitish or buffy patch of contrasting pelage immediately behind the ear.

#### KEY TO THE SPECIES OF *DREMOMYS*

1. No yellow, orange, or red colored pelage.....*everetti* (extraterritorial)  
Some yellow, orange, or red colored pelage.....2
2. Under surface of tail not red.....3  
Under surface of tail brilliantly red full length.....4
3. Ventral pelage of body all gray at bases but all yellow or orange tipped (No reddish brown anal pelage patch).....*lokriah*  
Ventral body pelage all white tipped or partly yellow tipped but color patch of Burnt Sienna present about anus.....*pernyi*
4. Sides of head (but not the top of it nor the throat) bright red, flash mark on hip inconspicuous.....*rufigenus*  
No red on head, flash mark on hip conspicuous.....*pyrrhomerus pyrrhomerus*  
Head entirely red, flash mark on hip conspicuous (sometimes spreading over entire thigh).....*pyrrhomerus riudonensis*  
Flash marks on cheeks and hips inconspicuous but throat red.  
*pyrrhomerus gularis*

#### ***Dremomys lokriah* (Hodgson)**

*Definition.*—The species *Dremomys lokriah* includes the subspecies *lokriah*, *macmillani*, *garonum*, and *pagus*, and the named forms included in these as synonyms. The species distribution is mapped in Figure 24.

*Diagnosis.*—The species *lokriah* is characterized by (1) The dorsal pelage is plain, dull agouti without red on cheeks or hips. (2) The ventral pelage is yellow or orange without any reddish-brown perineal patch. (3) The under side of the tail is not red. (4) There are white tips to the tail hairs.

The species *lokriah* is distinguished from the other species of its genus by the above characters as follows: from *pernyi* by 2; from *rufigenis* by 1, 2, and 3; from *pyrrhomerus* by 1, 2, and 3; from *everetti* by 2 and 4.

*Relationships to other species.*—Zahn (1942) includes in the species *lokriah* approximately the geographic races that we assign to it here, but he adds to it a lumping of the races which previously belonged to a separate species, *Dremomys pernyi*. Anthony (1941, p. 91) took samples of both *lokriah* and *pernyi* in the vicinity of Imau Bum in northeast Upper Burma, and they differ sharply at this locality. The ventral pelage of the *pernyi* material is white, and that of the *lokriah* Orange Ochraceous. The skulls of *pernyi* are trenchantly

long-snouted; those of *lokriah* are relatively short. We have also seen material representing both species, from 6000 feet in the Adung Valley about 130 miles farther north; and here again both pelage and skull showed the same trenchant differences. The total amount of this material seen is, of course, small (three *lokriah*, four *pernyi*), and the localities constitute the known eastern extremities of the range of *lokriah*. At the western limit of the range of *pernyi* some 300 miles within the range of *lokriah*, there does appear to be some interesting similarities between the local races of the two species. See the account of *D. l. macmillani* for details.

### *Dremomys lokriah lokriah* (Hodgson)

*Sciurus lokriah* Hodgson, 1836, Jour. Asiatic Soc. Bengal, 5, p. 232.

*Dremomys lokriah bhotia* Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 426.

*Dremomys lokriah subflaviventris* Thomas, 1922, Jour. Bombay Nat. Hist. Soc., 28, p. 429.

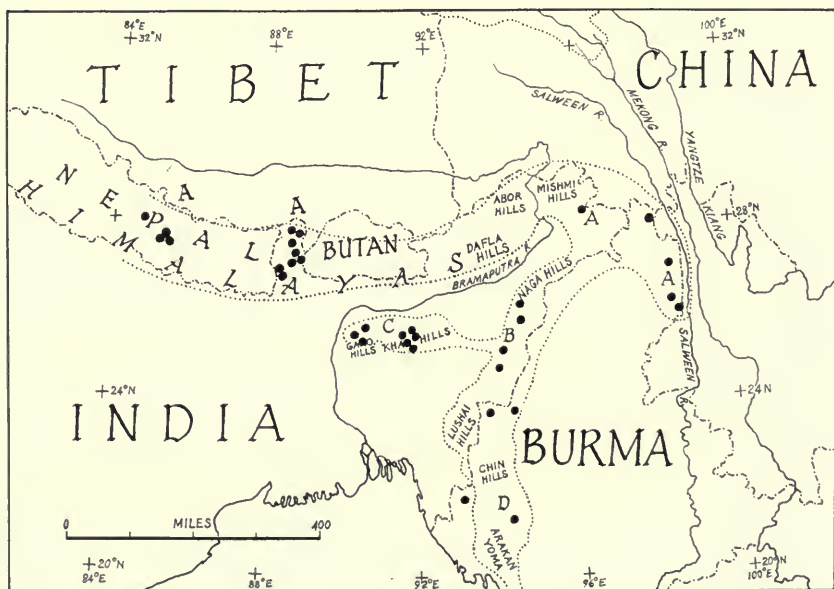


FIG. 24. Geographical distribution of the Himalayan long-nosed squirrel, *Dremomys lokriah*, as shown by collecting locality records of material examined. Dotted lines enclose mountainous areas probably inhabited by this species, but should not imply that it crosses the Salween River. Subspecies: A, *lokriah*; B, *macmillani*; C, *garorum*; and D, *pagus*.

*Types*.—*Sciurus lokriah*, BM Nos. 43.1.12.55 and old male 43.1.12.56 (cotypes) both from Nepal; *bhotia*, BM No. 15.9.1.125, old male collected at Sedonchen at 6500 feet elevation, Sikkim, India, November 14, 1914, by C. A. Crump; *subflaviventris*, BM No. 79.11.21.351, old adult from Assam, collected by John McClelland.

*Material examined*.—"Nepal" (BM), seven, (RNH), one; "Tibet" (RNH), one; Chandragiri Pass, 7000 feet, Nepal (BM), one, (USNM), four; Hathiben, Nepal (BM), one; Godaveri, 7000 feet, Nepal (USNM), one; Sattha, 2 miles northwest of Gorkha, Nepal (BM), one, (CNHM), one; "Sikkim," 9000 feet (BM), two; Sukiapokhri [Sookia Pokhari], 7000 feet, Darjeeling (BM), three; Darjeeling, 7000 feet, Sikkim (BM), two; "Jeluk," 9800 feet, Sikkim (USNM), one, (CNHM), 10; Gopaldhara, Rungbong Valley, Sikkim (CNHM), one; Lachen, 8800 feet, Sikkim (CNHM), one, at 6000 feet (BM), one; Gangtok, 7000 feet, Sikkim (BM), one; Ringin, 6000 feet Sikkim (BM), one; Chungtang, 5350 feet, Sikkim (USNM), one, (CNHM), six; Sedonchen, 5500 to 6500 feet, Sikkim (BM), three; Lachung, 8000 feet, Sikkim (CNHM), one; Dreyi, 5140 feet, Mishmi Hills, Tibet (BM), seven; Nyetmaw River, 8600 feet, Burma (AMNH), one; Mt. Imaw Bum, 9000 feet, Burma (AMNH), one; Taron Valley, 7000 feet (BM), one; Akhe Triangle, 3500 feet (BM), one; Adung Valley, 6000 feet (BM), two, (CNHM), one.

*Original description*.—"Above, saturate brown, tipped with intense orange; below, and the thighs, deep orange. Tail concolorous with body above, distichous, flattened, and broad, with a double margin of black and hoary."

*Type descriptions*.—The types of *lokriah*, like *subflaviventris*, *bhotia*, and *garonum* have the underparts dull mustard yellow, in contrast to the yellowish white of *macmillani*. The Leiden (RNH) specimens are dark gray-brown, a grizzle of buff tips in gray bases, the deep bases smoky. The underparts deep orange. No orange at base of tail. Throat buffy white. Dorsal color unchanged on hands and feet.

*Pelage color*.—The color of the ventral pelage being diagnostic, it seems worth while to mention that that of the United States National Museum material from Nepal was recorded as Ochraceous Orange. That of the Chicago Natural History Museum material from Sikkim was with very little variation, Salmon Orange, excepting in one or two of the adults where it approached Xanthine Orange closely. That of the American Museum material from northern Burma is



Ochraceous Orange. Salmon Orange is, of course, very near Ochraceous Orange.

*Discussion.*—The Chicago Natural History Museum series of *D. lokriah* from Sikkim convinced us that there are not two good geographic races involved there, separated by the Teesta River as proposed by Wroughton (1916c). In the attenuated distribution of the race *D. l. lokriah* across the face of the Himalayas, the Dafla, Abor, and Mishmi hills, and into the mountain massif of northern Burma, one would look for variation. The American Museum material available from very northern Burma seems to provide a reduction in size, but the sample (2) is much too small to demonstrate geographic subspeciation.

Material from the range of *D. l. lokriah* as we recognize it here, is rather scarce, and it samples widely separate localities. Nevertheless, the pelage characters of the Adung Valley, Burma, specimen, for example, make it inseparable from the series of skins from Sikkim. In skull characters we find virtually no geographic variation between the subspecies of *lokriah*, but in the very small samples of skulls that we have measured from the eastern and western extremities of the range of *D. l. lokriah*, the auditory bullae run proportionally smaller than in Sikkim. The sample from the western extremity (Nepal) also has a proportionally longer orbit, and one wonders if the Arun Valley is not a rather effective barrier to any east-west passage of this squirrel, isolating the main Nepalese population from interbreeding with the population east of this river.

*Habits.*—Lord Cranbrook (*in* Kinnear, 1934) noted that *Dremomys pernyi* and *D. [lokriah]* seemed in the Adung Valley to replace *Callosciurus erythraeus* where the forest changed from subtropical to a more temperate type with conifers. This is quoted in the present paper in the account of *C. flavimanus quinquestriatus*.

Another observer who collected this species comments: "Common in all the forests from 5,000 to 9,000 feet. Lives in holes in trees, generally low down and is frequently seen on the ground, feeding on fallen nuts and berries. As a rule it is silent but on occasion utters a loud cackling note. When approached it hides itself by lying flat along a branch, and does not attempt to leave the tree unless really frightened." (C. A. Crump *in* Wroughton, 1916a, p. 488)

### ***Dremomys lokriah garonum* Thomas**

*Dremomys lokriah garonum* Thomas, 1922, Jour. Bombay Nat. Hist. Soc., 28, p. 430.

*Type*.—BM No. 21.1.6.54, adult male from Tura, 1200 feet, Garo Hills, Assam, collected February 25, 1920, by H. W. Wells.

*Material examined*, all from Assam, India.—Tura Mt., Garo Hills (CNHM), one; Duragiri [Darugiri] 3000 feet, Garo Hills (BM), one; "Rajapara," 600 feet, south Kamrup (BM), one; Umran, Khasi Hills (AMNH), two; Bara Pani [Borpani], Khasi Hills (AMNH), two; Nongpoh, Khasi Hills (AMNH), three, (CNHM), one; Pynursla, Khasi Hills (CNHM), one; Mawphlang, Khasi Hills (CNHM), 34; Mawlyngkueng, Khasi Hills (CNHM), four; Laitlynkot, Khasi Hills (CNHM), one; Cherrapunji, Khasi Hills (CNHM), two; and "Konshnong," 3000 feet, Jaintia Hills (BM), three.

*Original description*.—"Size about as in . . . *lokriah*, or slightly smaller. Colour above as in *D. l. [lokriah]* but below . . . it is far paler and more yellow, nearly matching Ridgeway's 'orange-buff.' Buffy of underside narrowed. . . . Readily distinguishable by the paleness of its lower surface."

### ***Dremomys lokriah pagus* Moore**

*Dremomys lokriah pagus* Moore, 1956, American Mus. Nov. No. 1816, p. 1.

*Type*.—AMNH No. 163479, an adult male from 1400 meters elevation on Mt. Victoria in the Pakokku Chin Hills of western Burma, collected March 23, 1938, by Gerd Heinrich.

*Material examined*.—Mt. Victoria, Pakokku Chin Hills, Upper Burma (AMNH), 18; Sangau, Lushai Hills, Assam (CNHM), six.

*Pelage color*.—Dorsal pelage like that of subspecies *lokriah* and *garonum*; ventral pelage with bases of Slate Gray and tips of Ochraceous-Buff. Colored hair tips are longer on the throat so that Slate Gray does not show through there; in the rest of the ventral pelage it does.

*Diagnosis*.—*Dremomys l. pagus* differs from subspecies *lokriah* and *garonum* by paler, more yellow ventral pelage; from *macmillani* by lacking a distinct anal area pelage color patch, and usually by lacking a middorsal blackish stripe.

*Discussion*.—This is the southernmost geographic race of *D. lokriah* and its type locality is our southernmost locality record for the species. It is only in contact with *macmillani* and presumably intergrades with it in the Chin Hills and to some extent the Lushai Hills—a third of the Lushai Hills specimens having the blackish middorsal line.

**Dremomys lokriah macmillani** (Thomas and Wroughton)

*Dremomys macmillani* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 238.

*Type*.—BM No. 15.5.5.198, young male from Tatkon, 250 feet, west bank of the Chindwin River, opposite Kindat, Burma, collected June 27, 1914, by S. A. Macmillan.

*Material examined*, all from Assam, India.—Mokokchung, 4000 feet, Naga Hills (BM), one; "Naga Hills," 5000 feet (BM), two; Takubama, Naga Hills (CNHM), five; Karong, Manipur (CNHM), 12; five miles north of Imphal, Manipur (USNM), one; and Chin Hills, 5000 feet, 50 miles west of Kindat, Burma (BM), three.

*Original description*.—"Size about as in . . . *lokriah* . . . colour above dark coarsely grizzled olive-grey, clearer on fore-back, suffused with dull tawny on crown, nape, and hind-back; a distinct narrow black median line present . . . from the back of the nape to the loins. . . . Undersurface bright buffy, lighter anteriorly and on inner side of the forelimbs, darkening to cinnamon buff on the inner side of the hind limbs. . . . Anal region and base of tail beneath rich ochraceous-rufous. . . . Postauricular patches prominent, deep ochraceous buffy. . . . Tail hairs ringed with black and pale buffy, . . . tips white; no rufous . . . along underside. . . . distinguishable [from *lokriah*] by its distinct dorsal black line, its greyer general colour, the more completely buffy hairs of the underside, and by the greater prominence and buffy colour of the postauricular patches."

*Discussion*.—Takubama is evidently in the area of intergradation between *D. l. lokriah* and *D. l. macmillani*. Only one of the five from there possessed the middorsal stripe, and two the ventral pelage of *macmillani*; whereas two have pelage identical to that of the *D. l. lokriah* material from Sikkim, and one has a venter like the *D. l. lokriah* material from Imaw Bum and Nyetmaw River. From the material examined, Kohima, Karong, and Imphal are, however, firmly within the range of *macmillani*.

Examples of *Dremomys pernyi* have also been examined from Takubama, Karong, and Kohima, and there are the following similarities between the two local subspecies of the two species. Of the dozen specimens of *macmillani* from Karong, three have pure white pelage streaks occurring both in the middle of the throat and the middle of the chest in each individual. Half of the dozen Karong specimens have their entire ventral pelage as pale as Light Ochraceous-Buff (the others: 5 Ochraceous-Buff, 1 Orange-Rufous). The skin of one adult female *D. pernyi howelli* in the Takubama material

(CNHM 76344) is in its ventral color, intermediate between the species *lokriah* and *pernyi*. In the ratio of the orbito-nasal length to the greatest length of the skull, however, and in general character of the skull, this specimen is well outside of the range of the species *lokriah* and in that of the longer-nosed *pernyi*. The local race of the white-bellied species, *Dremomys pernyi howelli*, which inhabits the same area as *Dremomys lokriah macmillani*, like the latter is distinguished from its own conspecific relatives in part by a blackish mid-dorsal stripe. *Dremomys lokriah macmillani* is the only geographic subspecies of *lokriah* which possesses a characteristic color patch about the anus, which does, however, characterize the entire species *pernyi*. One might suspect this variable subspecies *D. l. macmillani* which so resembles *D. pernyi howelli*, of being a product of intergradation between the two species. Study of the skull material representing *macmillani* reveals no real suggestion, however, of any such intergradation or of species cross. There is a typical *lokriah lokriah* skin wearing the same number (CNHM 76312) as a typical *pernyi howelli* skull from Takubama in the Naga Hills, but this is assumed to be mixing of collected specimens.

### ***Dremomys pernyi* (Milne-Edwards)**

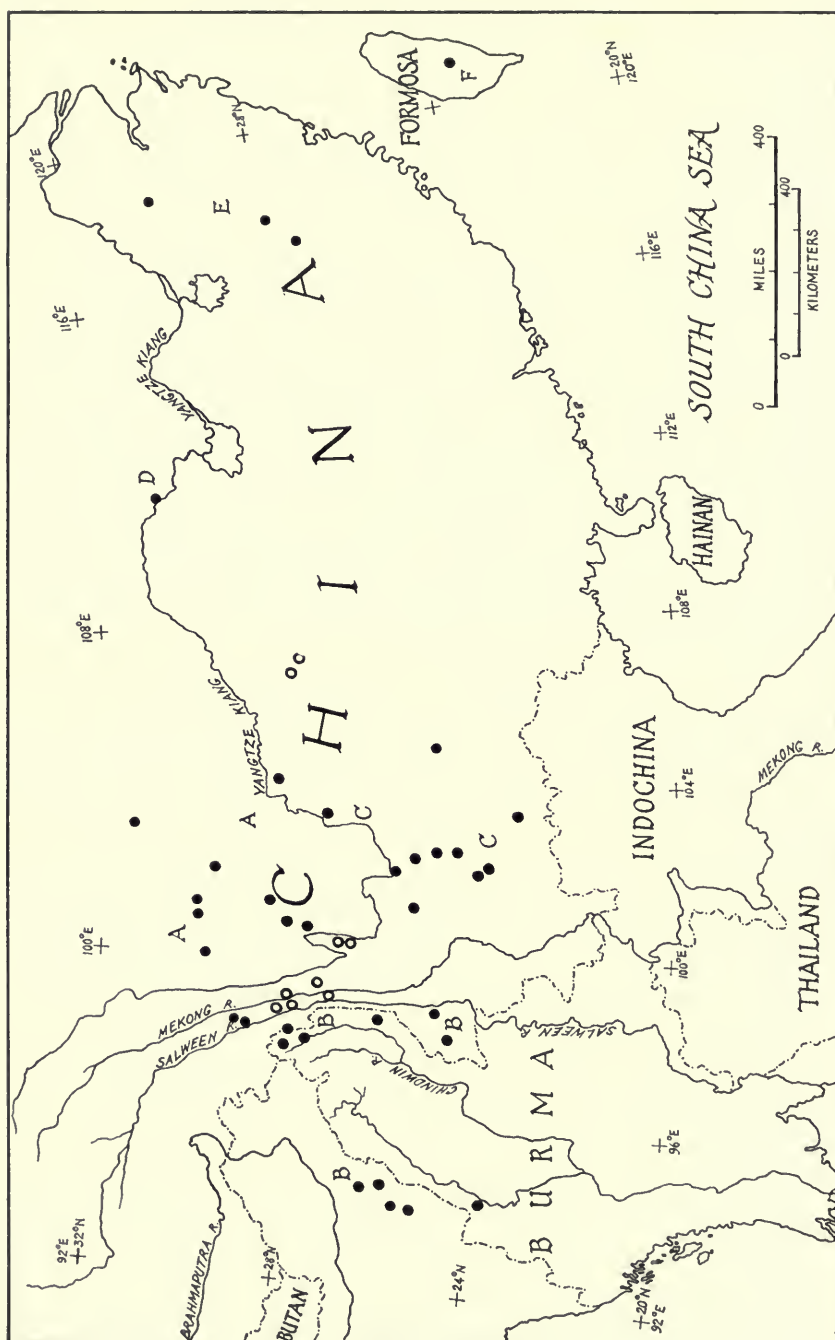
*Definition.*—The species *pernyi* is constituted by subspecies *pernyi howelli*, *flavior*, *senex*, *owstoni*, and *calidior*, and see the synonyms listed under these. The distribution of this species is mapped in Figure 25.

*Diagnosis.*—Characteristics of the species *pernyi* are: (1) The dorsal pelage is plain agouti gray without flash mark on hip or red cheek. (2) The ventral pelage is marked by a reddish brown patch about the anus. (3) The ventral pelage is whitish on thorax and abdomen. (4) The ventral pelage of the tail is a faintly buffy gray. (5) The tail hairs are tipped with white.

The species *pernyi* is distinguished from other species of *Dremomys* by the above characters as follows: from *lokriah* by 2, 3, and 4; *rufigenus* by 1, 2, and 4; *pyrrhomerus* by 1, 2, and 4; and *everetti* by 1 and 5.

*Relationships to other species.*—As may be seen in comparing Figures 24 and 25, this species replaces the species *lokriah* on the east, and is sympatric with it in northern Assam and Burma. In central and eastern China there are so few collections that it is difficult to assess its relationships with species *pyrrhomerus*, with which it does in some manner appear to share this vast area. Both were collected





at Ichang, Hupeh; Pien Ngai, Szechwan; and Suiyang, Kweichow. To the south *pernyi* is replaced by species *rufigenis*. The ranges of three species, *lokriah*, *pernyi*, and *rufigenis* seem to overlap broadly in upper Burma.

Our study of this species with the rusty anal patch, reveals six geographic races as listed above. In this we find ourselves in fairly close agreement with Allen (1940, p. 646), but differing considerably with Zahn (1942, pp. 124, 127, 182), who recognizes only *pernyi* and *senex*, and Ellerman and Morrison-Scott (1951, p. 492), who admit only *pernyi*, *imus*, and *owstoni*.

### ***Dremomys pernyi pernyi* (Milne-Edwards)**

*Sciurus pernyi* Milne-Edwards, 1867, Rev. et Mag. Zool. (ser. 2), 19, pl. 19.

*Dremomys pernyi griselda* Thomas, 1916, Ann. Mag. Nat. Hist. (ser. 8), 17, p. 392.

*Dremomys pernyi lichiensis* Thomas, 1922, Ann. Mag. Nat. Hist. (ser. 9), 10, p. 403.

*Dremomys rufigenis lentus* A. B. Howell, 1927, Jour. Washington Acad. Sci., 17, p. 80.

*Types*.—*Sciurus pernyi* MNHN No. 1868-1331 (200), adult from "les montagnes de la principauté de Moupin," Szechwan, China, collected by Perny; *griselda*, BM No. 11.10.3.3, young female from Nagchuka [Hokow], 10,000 feet, Szechwan [Sikang], China, collected May 25, 1911, by F. M. Bailey; *lichiensis*, BM No. 20.1.16.2, young male from LiChiang Range, latitude 27° 20' N., Yunnan, China, elevation 10,000 to 12,000 feet, collected July, 1918 by G. Forrest; *rufigenis lentus*, USNM No. 240384, adult male from Wen Chuan Hsien, 6000 feet, Szechwan, collected August 14, 1924, by D. C. Graham.

*Material examined*, from Sikang.—Shoo-o-lo [Siolo or Singolo] West Szechwan (BM), one; Ramala Pass [Lamaya], Szechwan (USNM), one; Ta Chien Lu [Tatsienlu], 12,000 feet (CNHM), one, (MCZ), one; Mi-li (CNHM), four; Baurang (CNHM), one; Ti-yu Gomba [Dayul Gomba], 12,950 feet (CNHM), one; Yulong-Vilang [Yulong] (CNHM), one; Mupin (USNM), two; "Yao Gi" near Mupin (USNM), one; Tang Gu [Tangshu], near Gieu Long Shien, Tibet [Sikang] (USNM), four; "Wa Hu Pass," 14,000 feet, Tibet (USNM),

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FIG. 25. The species range of the Chinese long-nosed squirrel, *Dremomys pernyi*, as shown by plotted collecting localities of material examined. Open dots in this figure represent material intermediate in character between subspecies. Subspecies: A, *pernyi*; B, *howelli*; C, *flavior*; D, *senex*; E, *calidior*; and F, *owstoni*.

one; Nagchuka [Hokow] (BM), one; "Yao Chao," east of Mekong River, 13,000 feet (BM), one.

*Material examined*, intermediate with *D. p. howelli*, from Sikang.—Mekong-Salwin Divide, latitude 28° 20' N., 9000–10,000 feet (BM), seven.

*Material examined*, from Szechwan.—25 miles west of Wenchwan, 7000 feet (AMNH), four; "Wu-chi" (CNHM), four; "Meipeng" (CNHM), one; "Szechwan" (USNM), one.

*Material examined*, intermediate with *D. p. flavior*, all from Yunnan.—Nguluko (USNM), one; Lichiang [Likiang], 8000–12,000 feet (CNHM), eight, (MCZ), two, (USNM), seven, (AMNH), four; Lichiang Range, latitude 27° 30' N., 9000–11,000 feet (BM), 19; "Teshweko," 11,000 feet, Likiang Range (USNM), one; "Lhotan," 12,000 feet, Western Likiang Snow Range (USNM), one; Northern slope Likiang Snow Range (AMNH), one.

*Material examined*, from Yunnan.—"Hofuping Mts.," Kekong Valley (USNM), three; Li-tien and Wieshi Pass (AMNH), two; "Mts. of Yangtze, Mekong Valley" (USNM), one; Mekong-Yangtze Divide, 7000 to 8000 feet, latitude 27° 30' N. (BM), one; Mekong Valley, 7000 feet, at latitude 28° N. (BM), two; Mekong-Salween Divide, 7000 to 10,000 feet, latitude 28° 20' N. (BM), two; Tse-kow [Tseku], N.W. Yunnan (BM), one; Yung-ning (CNHM), four.

*Type description*.—Milne-Edwards (*loc. cit.*) published only the colored plate of the type of *pernyi* with no description or other details in words. The present (1951) appearance of the type is dull gray brown, a grizzle or mixture of yellowish and blackish brown. This color is uniform all over the back, limbs and feet, and onto the head. The tail is only slightly darker, due to a greater amount of black. Claws of the forepaws are rather long. The underparts are white from chin to vent. The anal region and inner sides of the hind limbs posteriorly are bright rusty brown.

*Discussion*.—This is a fairly distinct, large, northern race, distinguished from its conspecific neighbors on the south and west by its lighter gray dorsal pelage and tail.

The abundant material from the high mountain peninsula formed by a long loop of the Yangtze about Likiang has caused much confusion. Most of this material we find indistinguishable from *pernyi* of Sikang to the north, but some of it seems intermediate between *pernyi* and *flavior*; and it seems reasonable on geographic grounds to regard material of the species *D. pernyi* in the Likiang area as intergrade.

Just north of Likiang the narrow area between the Yangtze and Salween rivers, divided by the Mekong, is an area of intergradation between *D. p. pernyi* and *D. p. howelli*, whence the material is also abundant and may appear to represent either race. Thomas (1922, p. 400) came to regard this small area as that of typical *D. p. pernyi*, with *imus* across the Mekong to the west and *griselda* across the Szechwan (Sikang) border to the east, and with *griselda* 30' of latitude (34.4 miles) to the south and *griselda* 20' of latitude (23 miles) to the north. Whether the type specimen came from that area or more probably from near Muping, Sikang, the area occupied by a recognizable geographic subspecies which can logically bear the name *D. p. pernyi* is to the north and east in Sikang and Szechwan, and the characters which distinguish it are those which Thomas applied to his *D. p. griselda*.

### **Dremomys pernyi howelli** Thomas

*Dremomys pernyi howelli* Thomas, 1922, Ann. Mag. Nat. Hist. (ser. 9), **10**, p. 401.

*Dremomys pernyi mentosus* Thomas, 1922, Ann. Mag. Nat. Hist. (ser. 9), **10**, p. 401.

*Dremomys pernyi imus* Thomas, 1922, Ann. Mag. Nat. Hist. (ser. 9), **10**, p. 402.

*Types*.—*Dremomys p. howelli*, BM No. 12.8.26.2, old male from Ma-Chang-Kai, 6500 feet, about 25 miles S.W. of Tengyueh, upper Shweli River, extreme western Yunnan, China, collected June 4, 1912, by E. B. Howell; *mentosus*, BM No. 16.3.26.40, old female from 5000 feet in the Chin Hills 65 miles [6 in type description] southwest of Kindat, Upper Burma, collected May 13, 1915, by J. M. D. MacKenzie; *imus*, BM No. 20.8.7.7, old male from 7000 feet on the west slope of Mt. Imaw Bum, Upper Burma, collected October 21, 1919, by F. Kingdon Ward.

*Material examined*, from Yunnan.—Ma-Chang-Kai, 6500 feet, Tengyueh (BM), six; Shweli-Salween Divide, 7000–10,000 feet (BM), two; Tai-Ping-Pu, 7000 feet, Shweli River (AMNH), two.

*Material examined*, from Upper Burma.—Taron Valley, 4500 feet (BM), one; Adung Valley, 6000 feet (CNHM), two; Nam Tamai Valley, 3000 feet (BM), two; Gangfang, 5200 feet (AMNH), one; Tsonma, 8300 feet (AMNH), one.

*Material examined*, from Assam, India.—Manipur (BM), one; Karong, Manipur (CNHM), three; Kohima, Naga Hills (CNHM), one; Takubama, Naga Hills (CNHM), four.



*Original description.*—"Colour throughout like . . . true *pernyi*, or very slightly more yellowish olivaceous, but fore-back in every specimen there is an almost imperceptible blackish dorsal line from one to two inches in length. Under surface as in *pernyi*, . . . front aspect of lower legs dull whitish or more or less washed with reddish. Tail as in *pernyi*."

*Discussion.*—The above description is confusing, for Thomas had come to regard as typical *pernyi* certain material from what we must now regard as a zone of intergradation between typical *pernyi* and *howelli*, and also certain dark variant individuals from within the range of what Allen (1940, p. 648) and we recognize as subspecies *pernyi*. The characters of this proper geographic subspecies *pernyi* are in fact the ones by which Thomas (1916b, p. 392) distinguished his subspecies *griselda*.

While the small amounts of material available from the three extremes of the V-shaped geographic range of this subspecies can be to some extent distinguished and thus do provide some excuse for the three names, it seems quite certain that the difference will diminish as more material even from the extremes, becomes available. And it should be recognized that the materials from these three extremes of the range are more like each other than they are like the adjacent geographic races, *pernyi* and *flavior*.

*Dremomys p. howelli* as recognized here is characterized by a blackish middorsal line in the pelage, fainter in the eastern leg of its range than in the western, but present throughout. It may be otherwise distinguished from both *D. p. pernyi* and *D. p. flavior* by generally darker dorsal pelage and tail, and by the darker, richer colored anal patch. In series, furthermore, the venter of *flavior* is notably whiter.

*Habits.*—Lord Cranbrook (*in* Kinnear, 1934) noted that *Dremomys pernyi* and *D. [lokriah]* seemed in the Adung Valley to replace *Callosciurus erythraeus* where the forest changed from subtropical to a more temperate type with conifers. This is quoted in the present paper in the account of *C. flavimanus quinquestriatus*.

In a letter of June 10, 1961 to one of us, Lord Cranbrook contributed the following observations from his field notes made while collecting in the Adung Valley: "No. 237. Shot on the ground in jungle. No. 213. Snared by native on the ground; pregnant, three young. January, 5000 feet." Sizes of broods of tropical squirrels are so little known that no records were reported for *Dremomys* in a recent litera-

ture survey (Moore, 1961, pp. 21-26), hence this observation of brood size is of some importance.

### ***Dremomys pernyi flavior* G. M. Allen**

*Dremomys pernyi flavior* G. M. Allen, 1912, Proc. Biol. Soc. Washington, 25, p. 178.

*Type*.—MCZ, no. 13,691, young male, from Mongtz [Mengtsz], southeastern Yunnan, collected in 1911 by H. Orii.

*Material examined*, from Yunnan.—“Yunnan” (BM), five; 15 miles S.W. of Kunming [Yunnanfu] (USNM), two; Lung Kai [Lungkai], Wuting Hsien [Wutingchow] (AMNH), three; Kao Chiao (AMNH), two; Feng Yang (AMNH), three; Hsin Kai [Sinkai] (AMNH), one; Cuchi [Kuchai] (USNM), one; Yang Wu Pa (AMNH), two; “Udati” near Mongtze [Mengtsz] (BM), one; Huang Jia Keo [Huangchiakou] (USNM), two; Tseo Jia Keo, Yunnan border south of Suifu (USNM), four; “Szechwan” (USNM), one.

*Material examined*, from Kweichow.—Hwang Tsao Pa [Hwangtsaopa] (USNM), eight.

*Original description*.—“Similar to *D. pernyi* but smaller and yellow in general coloration. The median area of the under side of the tail is yellowish or buffy instead of whitish.

“Entire upper surface of the head . . . neck, body, limbs, and base of tail a nearly uniform grizzled buffy and black. . . . Chin, throat, belly and inner sides of the legs white, washed with pale buff on the throat. The white hairs, except on the chin, have dark slaty bases. Anal region pale ochraceous-rufous . . . extending onto the base of the tail below and the inner sides of the tibial margin of the legs.

“. . . Below the central area of the tail . . . is cream buff bordered by black and fringed with white. . . .

“Skull.—Compared with . . . *pernyi* from Szechwan [Sikang] . . . the new race is decidedly smaller. . . .”

*Discussion*.—This is a quite good geographic race of *D. pernyi*. One may distinguish it from the typical *D. p. pernyi* to the north by its consistently smaller size and darker, more olive dorsal pelage. Agreeing with Allen (1940, p. 649) regarding the distinctness of this race, we differ with him, however, in that we recognize this subspecies only south of the Yangtze River in Yunnan and Kweichow. The material from Litien and Weisi Pass, which he included in this, we find to be intermediate between typical *Dremomys pernyi pernyi* and *D. p. howelli*.

**Dremomys pernyi senex** (G. M. Allen)

*Dremomys senex* G. M. Allen, 1912, Mem. Mus. Comp. Zool., **40**, p. 229.

*Dremomys pernyi modestus* Thomas, 1916, Ann. Mag. Nat. Hist. (ser. 8), **17**, p. 393.

*Types*.—*Dremomys senex*, MCZ No. 7582, adult female from Nantow (or Nantu), Ichang Hsien, Hupeh, China, collected February 5, 1909 by Walter R. Zappey; *modestus*, BM No. 8.8.11.41, adult male from Sui-yang, Kweichow, China, collected in April, 1898, by F. W. Styan.

*Material examined*.—Ichang, Hupeh, China (BM), five, (MCZ), two; Suiyang, Kweichow (BM), two; Tungtze, Kweichow (CNHM), one; "Ta-tong Hsien," Kweichow (CNHM), one.

*Original description*.—"Nearest to *D. pernyi*, from which it differs in its greater size, with notably longer tail and larger skull, in having the postauricular patch white instead of deep ochraceous buff, and the median area of the ventral surface of the tail nearly uniform clay color instead of whitish."

*Pelage color*.—"Dorsal coloring essentially as in typical *D. p. pernyi* and *D. p. flavior* . . . a small postauricular patch of buffy or white. . . . A narrow buffy eye-ring is present and the cheeks are slightly tinged with ochraceous. Throat white to roots of the hairs, anteriorly, but the lower throat and the belly and the forearms are gray-based . . . a faint wash of yellowish buff . . . conspicuous on the border of the thighs. Tail above showing three black bands on the individual hairs, alternating with dull ochraceous buff to drab, and tipped with white; below, the white tips form an external fringe, succeeded by a black border, while the central area is drabby ochraceous. The usual ferruginous patch is present over the anal region extending to the upper part of the hind legs." (G. M. Allen, 1940, p. 651)

*Discussion*.—Since Thomas in describing *modestus* commented that it is nearer *senex*, we regard the name a synonym of *senex*, although the material from Suiyang, Tungtze, and Ta-tong Hsien seems intermediate between *senex* and *flavior*. Obviously there is much yet to be learned about the distribution of *senex*.

**Dremomys pernyi calidior** Thomas

*Dremomys pernyi calidior* Thomas, 1916, Ann. Mag. Nat. Hist. (ser. 8), **17**, p. 394.

*Dremomys pernyi chintalis* Thomas, 1916, Ann. Mag. Nat. Hist. (ser. 8), **17**, p. 394.

*Types*.—*Dremomys p. calidior*, BM No. 99.3.9.17, young adult male from Kuatun [Kaotien], northwest Fukien, China, collected by F. W. Styan; *chintalis*, BM No. 99.3.9.12, young female from Chinteh [Tsingteh], An-hwei, China, collected October 29, 1896, by F. W. Styan.

*Material examined*.—Kwatum [Kaotien], Fukien (USNM), two; Kuatun [Kaotien], northwest Fukien (BM), 13, (MNHN), one; Chungan Hsien, north Fukien (AMNH), 18; "N. W. Fokien" (AMNH), one; Chinteh [Tsingteh], Anhwei (BM), three.

*Original description*.—"General characters very much as in *D. p. senex*, but upper color a much warmer brown, approaching 'olive-brown.' Ear-patches mixed white and ochraceous, the bases of the hairs white and their tips ochraceous. Under surface whitish, but ordinarily with well-marked buffy thigh-patches."

In selecting one of these two synonyms for the name of this race, it should have been better housekeeping to have chosen the prior *chintalis* since it actually appears first on the page. As Allen (1940, p. 652) strongly suggests, further collecting may reveal the necessity of synonymizing both under the name *senex*, making a single brownish subspecies in eastern China.

### ***Dremomys pernyi owstoni* (Thomas)**

*Zetis owstoni* Thomas, 1908, Jour. Bombay Nat. Hist. Soc., 18, p. 248.

*Type*.—BM No. 8.4.1.35, adult female from Mt. Arizan, central Formosa, collected December 6, 1906, by A. Owston.

*Material examined*.—Mt. Arizan, Central Formosa (BM), seven; "Central Formosa" (CNHM), three.

*Original description*.—"Most nearly allied to *lokriah*, but larger and darker colored. . . . Under surface broadly and conspicuously washed with yellow or orange, the bases of the hairs slaty; in the anal region this colour passes into a ferruginous patch, . . . Skull with a very long muzzle, [nearly] equalling that of . . . *pyrrhom-erus*. . . ."

*Type description*.—The backs of the ears weakly buffy-white. Dorsal surface a dark brindle or grizzle of buffy and black or dark gray. Underparts generally dull yellowish, somewhat as in *lokriah*, but much paler. Under side of chin and throat grayish white. Yellowish of under parts diminished posteriorly and at rear of abdomen remains as a mere wash. Insides of fore limbs gray white, hind limbs



yellowish. Base of tail beneath and anal area dull rusty brown; distal part of tail beneath gray with trace of buff.

### **Dremomys rufigenis** (Blanford)

*Definition.*—The subspecies constituting the species *rufigenis* as it is recognized here, are *rufigenis*, *opimus* and the extraterritorial *belfieldi*. (See also the synonymy.) The distribution of this species is mapped in Figure 26.

*Diagnosis.*—The distinguishing characteristics of species *rufigenis* are (1) The pelage of the cheeks is red. (2) The ventral pelage of the tail is rich red. (3) There is no rich red color patch in the dorsal pelage of the thigh, and the throat is not bright red.

The above characters distinguish species *rufigenis* from other species of *Dremomys* as follows: *lokriah* by 1 and 2; *pernyi* by 1 and 2; *pyrrhomerus* by 3; *everetti* by 1 and 2.

*Intraspecific variation.*—Like *Dremomys pernyi* the present species has in the past been divided rather freely into numerous, faintly differentiated subspecies. It is a semi-terrestrial foothills species, generally found at less than 5000 feet elevation. Its range centers about northern Thailand, but extends south from there into the Malay States, north through upper Burma a short distance into Assam on the west and eastward into the edge of Yunnan, China. It occurs throughout hilly Laos, Tonkin, and Annam, and north a little from Tonkin into the adjacent edge of Yunnan. See Figure 26.

The distinguishing characters of the species *rufigenis* are two: the brilliant colored red pelage of the cheeks, and of a ventral posterior region including both the anal area and the full-length of the undersurface of the tail. The cheeks vary from as pale as Orange Rufous to as intense as Dragon's-blood Red, and the other patch from Dragon's-blood Red to Brazil Red and occasionally even approaching Morocco Red. These marks contrast with the drab, olive-gray agouti pelage which rather uniformly cloaks the back and sides and upper surfaces of the appendages throughout this genus. Post-auricular patches are small and usually white or buffy. A suggestion of a black middorsal line has been noted in some material from the northwest and southeast extremes of the species range. The ventral body pelage is gray at the base and white at the tips. The dorsal tail hairs are white-tipped and have a long subapical black band (ca. 10–12 mm.) below which is a quite white band less than half as long, and a basal portion of less intense black. The dorsal pelage of the feet,



FIG. 26. The species range of the red-cheeked long-nosed squirrel, *Dremomys rufigenis*, as shown by plotting collecting localities of material examined. Subspecies: A, *rufigenis*, B, [extraterritorial] *belfieldi*; C, *opimus*. The dotted line between the localities for *rufigenis* and *opimus* separates these two subspecies as known from the localities plotted here, but is not offered as a boundary line between the subspecies.

limbs and hindquarters and also the ventral pelage of the body, are subject to infusion with warm buff color in some geographic areas.

Seven names have been proposed as subspecific variants within *Dremomys rufigenis* as we recognize the species here. We are unable to see any justification now for retention of more than three, the centrally located typical race, and one each in the northernmost and southernmost extremities of the arms of its range extending narrowly out from there.

### ***Dremomys rufigenis rufigenis* (Blanford)**

*Sciurus rufigenis* Blanford, 1878, Jour. Asiatic Soc. Bengal, **47**, part 2, p. 156, pl. 8 (in color).

*Funambulus rufigenis fuscus* Bonhote, 1907, Abstr. Proc. Zool. Soc. London, p. 2; 1907, Proc. Zool. Soc. London, **1**, p. 10.

*Dremomys rufigenis adamsoni* Thomas, 1914, Jour. Bombay Nat. Hist. Soc., **23**, p. 25.

*Dremomys rufigenis ornatus* Thomas, 1914, Jour. Bombay Nat. Hist. Soc., **23**, p. 26.

*Dremomys rufigenis laomache* Thomas, 1921, Ann. Mag. Nat. Hist. (ser. 9), **7**, p. 182.

*Types*.—*Sciurus rufigenis* (lectotype, Thomas, 1921, p. 183) BM No. 91.10.7.81, an adult male from above 5000 feet on Mt. Mooleyit, Tenasserim, Burma, taken February 17, 1877, by W. T. Blanford; *fuscus*, BM No. 6.11.6.28, an old individual from Bali, 250 meters, near Nhatrang, Annam, taken November 10, 1905, by Dr. Vassal; *adamsoni*, BM No. 14.4.3.3, a young male from southeast of Maymyo at 2800 feet in Burma, taken July 13, 1913, by J. P. Cook; *ornatus*, BM No. 12.7.25.20, an old female from Yunnan, China, probably near Mongtze, collected February 4, 1910, by Alan Owston's collector H. Orii; *laomache*, BM No. 20.12.10.2, an old female from "Ban Hoi Mak camp," 39 miles southwest of Ti Lao, near Pak Hin Bun, Mekong River, Laos, taken on February 29, 1920, by Herbert C. Robinson and C. Boden Kloss.

*Material examined*, from Assam, Upper Burma, and western Yunnan.—"Animole," Manipur (BM), one; Gokteik, 2133 feet, northern Shan States (CNHM), one, (BM), one; Kalaw, 4500 to 4800 feet, Southern Shan States (BM), two; Kindat, 250 feet, Chindwin River (BM), four; Pyaunggaung, 2794 feet, Northern Shan States, Burma (BM), three; Ratnamti, 2000 to 2500 feet, Upper Burma (BM), two; Thamaung [Thandaung], 20 miles E. of Tonjoo [Toungoo], Burma (CNHM), one; "Ta-ho," Ind'p't Kareni [*Karenni*], Burma (USNM), one.

*Material examined*, from Thailand.—Chiengmai [Muang Chiang Mai], 700 feet (BM), one; Doi Sritepe [Doi Suthep], 900 meters, Chiengmai, Siam (BM), one; Khun Tan [Doi Khun Tan], N. Siam (USNM), four; Khun Tan Mts. [Doi Khun Tan], 3000 feet, Siam (USNM), one, (CNHM), one; Me Taw Forest, 1200 feet, Raheng, Siam (BM), one; Southwest Siam, 14° 20' N., 99° 00' E. (BM), one; Doi Hua Mot, Siam (USNM), one; Doi Angka [Doi Ang Ka=Doi Inthanon], Siam (USNM), one, (MCZ), 14; Doi Chiengdao [Doi Chiang Dao=Doi Luang Chiang Dao=Doi Laem], Siam (USNM), two; Doi Sutep [Doi Suthep], Chiengmai, Siam (USNM), one, (AMNH), two; Hue Yah Pla [Huai Nua Pla], Siam (USNM), one; Doi Lak Sen [Doi Lak Saen], Siam (USNM), one; Doi Pu Kha [Doi Phu Kha], Siam (USNM), one; Doi Nangka [Doi Lanka=Khao Pha Choj], Siam (USNM), one, (CNHM), one; "Sawan Mtn., Nua, Ban Seio," *Loei* (USNM), one; "Ban Muang Khai," 1000 feet, *Ta Li*, *Loei* (USNM), five; "Lom Lo Mtn., Ban Maeo, Goksatawn," *Dan Sai* (USNM), 11; "Nam Lang Mtn.," *Ban Khok*, Naphung, *Dan Sai* (USNM), one; "Ban Na Muang, Na Hao," *Dan Sai* (USNM), two.

*Material examined*, from Indochina.—Backan [Bac Kan], 500 feet, Tonkin (BM), three; Boa-ha, Tonkin (BM), one; Chapa, 5000 feet, Tonkin (BM), seven, (MCZ), two, (USNM), two, (CNHM), six; Pakha, 1400 meters, Annam [Pa Kha, Tonkin], (CNHM), one; Col de Taloun, Laos (MCZ), two; Lo-gui-ho, 5000 feet, Tonkin (BM), one; Moug Mo, Tonkin (USNM), one, (CNHM), two; Ngoi Tio, Tonkin (BM), one; Phu Kobo, Laos (MCZ), one; Tam-dao, 3000 feet, Tonkin (BM), three; Lieng San [Leng Sang], Tonkin (CNHM), one; Col des Nuages, 400 meters, Annam (BM), five; Moug Moun, 1200 feet, S. of Lai Chau, Tonkin (CNHM), one; Dak-to, Annam (BM), one; Muong Yo, 2300 feet, Laos (CNHM), two; Djiring, 3500 feet, Annam (BM), one; Kontoun [Kontum], Annam (BM), two; Phong Saly, 4400 feet, Laos (CNHM), one; Nape, 2500 to 3000 feet, Laos (BM), two; Ban Ton Phung, Laos (USNM), one; Xien Quang-Koo, Laos (BM), five; Bali, 250 meters, near Nhatrang, Annam (BM), two; Langbian Peak, Annam (BM), one, (MCZ), one, (CNHM), 11; Fimnon, S. Annam (USNM), one; 1000 feet above Thateng [Ban Thateng, Laos], F.I. (CNHM), one; Thua-Luv, 150 feet, Annam (BM), one.

*Material examined*, from Lower Burma.—Ban Sompan, Lower Burma (AMNH), one.

*Original description*.—"Upper parts dark olive, frizzled, cheeks ferruginous, a small white spot behind ear, lower parts white; tail



hoary, black with white rings in tips above, chestnut below. The hairs of lower parts are dark grey at the base, white at the ends, there is a tinge of rufous on fore neck and throat in some specimens. . . . Tail clad above with black hairs having a white ring near, but not at their base, and white tips . . . lower surface of the tail chestnut . . .

"Skull differs . . . in the narrow and singularly elongate nasal portion. . . . The nearest approach [to *rufigenis*] is perhaps made by *S. pernyi* . . . [which] has a yellow spot behind the ear. . . . *Sciurus lokriah* also possesses . . . a small whitish tuft behind the ear. . . ." Thus from the very beginning Blanford correctly associated *rufigenis* with *pernyi* and *lokriah*.

The Indian Museum cotype has the dorsal color a grizzle of brownish buff and black, the bases of the hairs dark gray. The head is more reddish, but the cheeks are clear chestnut without red. Backs of ears white, their edges gray. No basiauricular patch. Tail basally like the back, terminally darker, composed of hairs with buffy white bases, long blackish subterminal rings and short whitish tips. Hands and feet and thighs reddish brown. Under parts buffy white with gray bases from behind chin to base of tail. The chestnut of the cheeks on either side meets beneath the chin. The under side of tail from vent as far as observable (tip broken off) is bright rusty red, with overall width of 18 mm. Beyond, on either side the black of the subterminal rings described for the dorsal surface replaces the red.

***Dremomys rufigenis belfieldi* (Bonhote) [Extraterritorial]**

*Funambulus rufigenis belfieldi* Bonhote, 1908, Jour. Fed. Malay States Mus., 3, p. 9, pl. 1 (in color).

*Type*.—BM No. 6.10.4.33, adult female from Gunong Ulu Kali, Selangor, 4800 to 5800 feet, collected February 9, 1906, by H. C. Robinson.

*Material examined*.—Bukit Fraser, Pahang, Malaya (USNM), one; Semangko Pass, Selangor-Pahang boundary, 2500 to 4500 feet (BM), two; Gunong Ulu Kali, Selangor, 4800 to 5800 feet (BM), two; Kao Tung Sawng [Khao Na Khae], Peninsular Siam, 2500 feet (BM), one.

*Original description*.—"Differs from the typical *rufigenis* in having the back paler and slightly grizzled. The hairs are dark at their bases with reddish tips, whereas in the typical *F. rufigenis* they are of a much brighter red, which is continued to their base the small

patch behind the ear . . . buffish [in *rufigenis*], is in this form pure snow white.

"The much redder cheeks and snow-white patch behind the ear form very characteristic marks of this race by which it may be easily distinguished."

*Habits*.—Robinson and Kloss (1915, p. 122) report that, "In Selangor this squirrel is confined to the ridges of the higher mountains where it lives a partially terrestrial existence among the giant *Pandanus* and the zerophytic plants clothing the summits. In Bandon on the other hand it descends the hills and is found on the ground amongst the ordinary tropical vegetation of a submontaine forest." Their two from Bandon were from above 1200 feet elevation.

### ***Dremomys rufigenis opimus* Thomas and Wroughton**

*Dremomys rufigenis opimus* Thomas and Wroughton, 1916, Jour. Bombay Nat. Hist. Soc., 24, p. 237.

*Type*.—BM No. 15.5.5.195, adult male from Hkamti, east bank of upper Chindwin River, 500 feet elevation, collected July 25, 1914, by G. C. Shortridge and S. A. Macmillan.

*Material examined*.—Kaunghein, E. Bank [Chindwin R.], Northern Burma (AMNH), one; Tasu Bum, Northern Burma (AMNH), one; Mokokchung, Naga Hills, 5000 feet (BM), two; Nanyaseik, Northern Burma (AMNH), one; Hkamti, Upper Chindwin, 500 feet (BM), one; Chenga Hka, Northern Burma (AMNH), one; Lahkaw Hka, Northern Burma (AMNH), one; Nam Tamai Valley, 4000 feet, 27° 42' N., 97° 58' E. (BM), one; Chu-Tun, 8000 feet, Yunnan (BM), one.

*Original description*.—"Like *adamsoni* . . . but darker and richer in colour throughout . . . colour of back more suffused with rufous. . . . Posterior back and hips suffused with ferruginous instead of the lighter and more buffy suffusion of *adamsoni*. Muzzle deep ferruginous . . . crown mixed with ferruginous and black, as compared with the grey crown of *adamsoni*. Postauricular patch white, much larger and more conspicuous than in [*adamsoni*]."

### ***Dremomys pyrrhomerus* (Thomas)**

*Definition*.—The poorly known species *pyrrhomerus* is composed of three very distinct subspecies, *pyrrhomerus*, *riudonensis*, and *gularis*, and their distribution as known to us from material examined is shown in Figure 27.



FIG. 27. The geographic range of the red-hipped long-nosed squirrel, *Dremomys pyrrhomerus*, as indicated by plotting collecting localities of material examined. Subspecies: A, *pyrrhomerus*; B, *gularis*; C, *riudonensis*.

**Diagnosis.**—The diverse species *pyrrhomerus* possesses the following characteristics of the pelage: (1) There is a red patch in the dorsal pelage of the thigh, or a red throat. (2) The ventral pelage of the tail is rich red. The first of these two characteristics distinguishes *pyrrhomerus* from *rufigenis*, and both characteristics distinguish *pyrrhomerus* from the other three species of *Dremomys*.

**Relationships to other species.**—Zahn (1942, pp. 135–138) recognizes no species *pyrrhomerus* but treats *pyrrhomerus*, *riudonensis*, *gularis*, and *melli* as subspecies of *D. rufigenis*. Allen (1940, pp. 654–657) treats the three of these four known to occur in China the same way. Our view of *pyrrhomerus* as a separate species is in agreement with that of Osgood (1932, p. 284). The range of *D. p. pyrrhomerus* is separated by a 400-mile hiatus from the nearest parts of the known range of *rufigenis*. This area is not represented well by collections of any squirrel species, and this hiatus may or may not be real. We have seen 73 specimens of subspecies *pyrrhomerus*, and its pelage dif-

ferences from *rufigenis* are possession of a prominent red thigh patch and lack of the red cheek patch. The measurable difference in length of snout is considerable, as shown in Figure 28. The difference in the appearance of the skulls is greater than that between *rufigenis* and *lokriah* or between *rufigenis* and *pernyi*. The degree of difference is, therefore, as exemplified by species within the genus, apparently one of species rank.

There are two poorly-known forms located geographically between the general range of *rufigenis* and that of subspecies *pyrrhomerus*. One is *riudonensis* from Hainan and the nearby mainland. We have seen only the type series of five specimens of this, from Hainan, but we have synonymized the known material of the other poorly-known form, *melli*, from the nearby mainland with *riudonensis* on the basis of the type description. This squirrel has the strong red thigh patch of *pyrrhomerus*, red cheeks like *rufigenis* but red all over the sides and top of the head as well. The small series of broken skulls appear to be structurally more like *pyrrhomerus* than *rufigenis*. The color characters appear superficially to be intermediate between *rufigenis* and *pyrrhomerus* but the total relationships appear to be closer to *pyrrhomerus* even though *riudonensis* is geographically much nearer to the known range of *rufigenis*. We are skeptical, therefore, of the existence of a breeding connection between *rufigenis* and *riudonensis*.

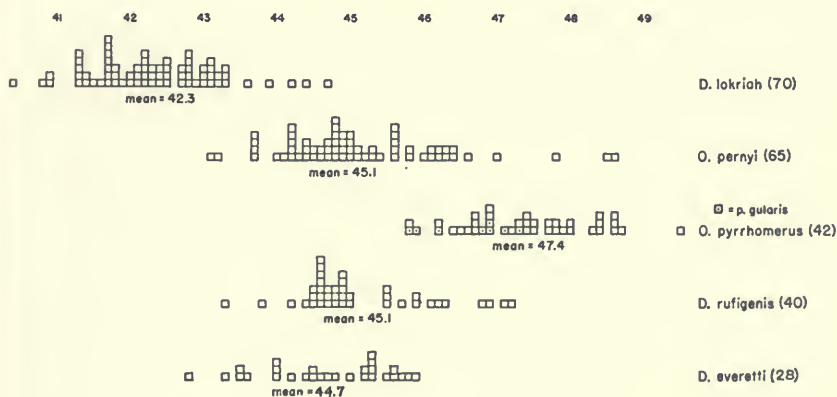


FIG. 28. Comparison of museum material representing the five species of *Dremomys* in orbitonasal length, presented as percent of total skull length. Arithmetic mean for each species is given below the histogram, and the size of the sample for each species is indicated in parentheses after the name. The distribution of this character in the subspecies *D. p. gularis* is indicated within that of its species by dots. Each square represents one specimen.



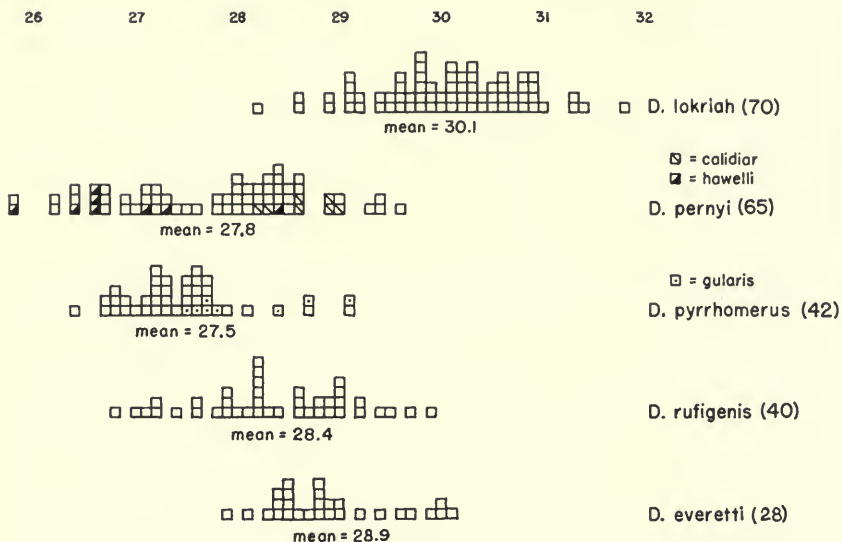


FIG. 29. Comparison of museum material representing the five species of *Dremomys* in length of orbit expressed as percent of greatest length of skull. Arithmetic mean is provided for each histogram, and the size of the sample for each species is indicated in parentheses after the name. Each square represents a specimen. Where subspecies cluster prominently in the upper or lower range for their species in a character, this is shown by special symbols.

More complicated even than the relationships of *riudonensis*, are those of *gularis*. We have examined 38 specimens of this form, however. This squirrel is known only from the vicinity of Cha Pa, Tonkin, and possibly only from the top of the one mountain, Fan Si Pan. *Dremomys rufigenis* was taken on all sides of this locality, possibly always at lower elevations, and there are evidently no intermediate specimens. Red cheek and red thigh marks both seem to be present but obsolescent in *gularis*. It possesses the brilliantly red under side of the tail in common with both species *pyrrhomerus* and *rufigenis* but differs from either of them by having the throat and under side of the hind legs colored almost as red. These latter characters are faintly suggested in occasional individuals of both *rufigenis* and *pyrrhomerus*, but are intense and constant characters in the sample of *gularis*. One color character which it shares with *pyrrhomerus* is a faint, blackish middorsal stripe noticeable in about half of the specimens. This occurs also in one geographic race each of *lokriah* and *pernyi* but not at all in *rufigenis*. Osgood (1932) in describing *gularis* as new, noted that the resemblance between skulls of *gularis* and

*pyrrhomerus* is close. We observe that in Figure 29 in proportional length of orbit, *gularis* agrees better with *rufigenis*, and that in Figure 28 in proportional length of snout, *gularis* lies between but perhaps a little nearer *pyrrhomerus*. In rather intangible general appearance and in larger size, *gularis* is more like *pyrrhomerus*. Because of the altitudinal relationship between *gularis* and *rufigenis*, and absence of intergrades, they are more likely to be specifically distinct than subspecifically. We consider that *gularis* is best placed as a subspecies in the species *pyrrhomerus* until someone can bring new evidence to bear.

### ***Dremomys pyrrhomerus pyrrhomerus* (Thomas)**

*Sciurus pyrrhomerus* Thomas, 1895, Ann. Mag. Nat. Hist. (ser. 6), 16, p. 242.

*Type*.—BM No. 2.6.10.66, adult female from Ichang, north bank Yangtze River, longitude 111° 20' E., China, collected November, 1893, by F. W. Styan.

*Material examined*, from Szechwan.—30 miles south of Chunking (BM), one; "Huo Chiao Pa" (USNM), two, (CNHM), four; "Yen-Ching-Kao," Wanhhsien (AMNH), 21, (CNHM), eight; "Tan Kao" (CNHM), one; "Yen Tien Pa" (CNHM), two; Yung Cha Shan (CNHM), two; Lu Chang Pu (CNHM), six; Pien Ngai (CNHM), four, (USNM), one; Wanhhsien (MCZ), five.

*Material examined*, from Kweichow.—Sunjang [Suiyang] (BM), four; Shuan Lung Chang (CNHM), one; Tung Wong Tien (CNHM), one; Hsing Liao Pa (CNHM), one; Wenpshui (CNHM), one; Tsunyi Hsien (CNHM), one.

*Material examined*, from Hupeh.—Chang Yang Hsien (MCZ), one; Ichang (BM), four; Tsuk kon Shih [Tung Shih] (MCZ), one.

*Material examined*, from Kansu.—"Ma Chu" (AMNH), one.

*Original description*.—" . . . Allied to . . . *S. rufigenis* . . . and *S. pernyi*, . . . with both of which it shares the olivaceous back, grey and white belly, yellowish postauricular spots, and characteristically coloured tail, white-grizzled black above and brilliant red below. Sides of cheeks with vague orange suffusion; anal region greyish white, like the rest of the under side. A large and prominent blotch on the outside of each thigh brilliant rufous.

"Skull with an enormously elongated muzzle . . ."

*Habits*.—Walter Granger collected the series from Yen-Ching-Kao, Wanhhsien during the winters 1921-26. In unpublished field notes at the end of 1922-23 he remarks, "The squirrels (5 specimens)

were all shot at one place, a rough rocky slope with coarse grass and some bushes bordering an area where corn is raised in the summer. These squirrels are almost entirely terrestrial apparently and live in holes in the rocks. During the winter months they come out only occasionally. . . . The species seems to be of very spotty distribution."

### **Dremomys pyrrhomerus riudonensis** (J. A. Allen)

*Funambulus riudonensis* J. A. Allen, 1906, Bull. Amer. Mus. Nat. Hist., 22, p. 472.

*Dremomys melli* Matschie, 1922, Beitr. Fauna Sinica, 88, p. 23.

*Types*—*Funambulus riudonensis*, AMNH No. 26651, adult female from Riudon, lowlands of Hainan, collected March 11, 1903 by A. Owston; *Dremomys melli*, ZMHU No. 43354, adult male from Yiu Shan, Kwangtung, 1000 meters, 230 km. north of Canton, collected by R. Mell.

*Material examined*.—Riudon, Hainan (AMNH), 4.

*Type description*.—The type of *riudonensis* appears to be in moult, as the wool hairs are exposed in the area behind the shoulders. The dorsal gray is tinged with reddish in unmoulted areas of the back. The head is bright reddish brown, shading to orange red on sides of head and cheeks. The hind limbs each have a strong reddish thigh mark. Feet and hands are grayish brown, the hands grayer than the feet. The ear bases have well-marked white spots. The underparts are very pale, whitish gray (the bases of the hairs are gray). The underside of the tail is bright rusty red from base to tip.

### **Dremomys pyrrhomerus gularis** Osgood

*Dremomys pyrrhomerus gularis* Osgood, 1932, Field Mus. Nat. Hist. Publ., Zool. Ser., 18, p. 284.

*Type*.—BM No. 32.4.19.5, an old male from Mt. Fan Si Pan, probably above 5000 feet, collected December 3, 1929, by Jean Delacour and W. Lowe.

*Material examined*.—Cha Pa, Tonkin (CNHM), 16, (MCZ), three, (USNM), one, (BM), 14; Lo-gui-ho, 5000 to 7000 feet, Tonkin (BM), six.

*Original description*.—"Similar to *D. pyrrhomerus* and *D. rufigenis* but chin and throat and inner sides of hind legs rich Ochraceous Tawny in abrupt contrast to other under parts [which are bluish, about Clear Payne's Gray]; flank patch obsolescent and reduced to a narrow line scarcely more evident than in *rufigenis*;

cheeks, nose and forehead less tawny than in *rufigenis*, nearly or quite as in *pyrrhomerus*."

*Discussion*.—Osgood's further remarks seem well worth quoting in part: "This is a very distinct form, . . . the fact that it occurs at high elevations within the area occupied by *rufigenis* lead[s] to the inference that it is most probably a southern representative of *pyrrhomerus*. . . . In cranial characters, also, the resemblance between the two is obviously close. . . ." We find that in orbitonasal length the sample of eight *gularis* fall in the lower half of the extremes for this measurement known for the species *pyrrhomerus*, and within the range of species *rufigenis* (see Figure 5). In orbit length the *gularis* sample might be said to fit better with the *rufigenis* sample than with that of the species *pyrrhomerus*. However, when compared in series, the *gularis* certainly look more like *pyrrhomerus* than like *rufigenis*.

### ***Dremomys everetti* (Thomas) [Extraterritorial]**

*Sciurus everetti* Thomas, 1890, Ann. Mag. Nat. Hist. (ser. 6), 6, p. 171.

*Type*.—BM No. 90.6.25.8, young adult male from Mount Penrisen, west Sarawak, collected in January of 1890 by A. H. Everett.

*Material examined*, all from Borneo.—Mt. Kina Balu (BM), three, (CNHM), two, (MCZ), 35, (USNM), 19; Mt. Penrisen, Sarawak (NR), one, (BM), two; Sarawak (NR), one; Mt. Tibang (MCZ), one.

*Original description*.—"Fur thick and soft, . . . Colour uniform dark grizzled olive, . . . sides of cheeks, shoulders, and front of hips with a very faint fulvous suffusion. Under surface dirty greyish white, the hairs everywhere slaty grey for two thirds their length, then tipped on the throat and belly with dirty white and on the chin and breast with dull fulvous. Ears short, rounded, not tufted or emphasized in colour. Tail unusually short, comparatively short-haired, almost cylindrical, the hairs ringed with dull fulvous and black. Skull small and lightly built, muzzle proportionally very long and narrow. . . . Molars small and delicate, their series on the two sides parallel. . . ."

*Definition*.—The species *Dremomys everetti* is monotypic and endemic to Borneo where it is a montane ground squirrel of the forest.

*Diagnosis*.—The species *everetti*, although conservative, is the most distinctive as well as the most isolated species of *Dremomys*: (1) It habitually develops a sagittal crest in the adult. (2) It has no whitish tips to the tail hairs. (3) It has no red pelage. (4) It has no rich yellow pelage. (5) It has a slight flash mark on the thigh.



The above characteristics distinguish species *everetti* from congeneric species as follows: from *lokriah* by 1, 2, 4, and 5; *pernyi* by 1, 2, and 5; *rufigenis* by 1, 2, and 3; and *pyrrhomerus* by 2 and 3.

*Systematic history*.—This species has endured some shifting about from one genus to another on the tides of developing opinion and knowledge of sciurid relationships in the Oriental Region. It was still called *Sciurus* (*Funambulus*) *everetti* as recently as 1900 by Oldfield Thomas, *Funambulus everetti* as late as 1933 by Banks, and *Rhinosciurus everetti* in 1940 by Allen and Coolidge. Placing of the species *everetti* in the genus *Dremomys*, however, dates back to the 1918 review of the Sciuridae of the Oriental Region by Robinson and Kloss.

*Pelage color*.—Color notes on stuffed skins of 22 adults of *Dremomys everetti* at the Museum of Comparative Zoology are offered here. Tips of ventral pelage generally are about Cream Color where the tips lie dense enough to eclipse the gray proximal color of the hairs. This density is most frequent on the throat or in the mid-sagittal ventral line. In a few individuals these tips are as pale as Light Buff, but in some of the males it is as rich as Light Ochraceous-Buff. On the chins the hairs are short and have no dark basal portion and are consistently Light Ochraceous-Buff. The basal portion of the ventral pelage varies among individuals from about Deep Neutral Gray to Dark Neutral Gray. The scrotum in eight adult males is covered with pelage which is brighter than Ochraceous-Buff if not attaining the intensity of Ochraceous-Orange. In one other adult male this scrotal pelage is but Warm Buff. The dorsal pelage is agouti with general color of Raw Umber in most specimens, but one (MCZ No. 36477) is infused with red and is Chestnut-Brown, and one or two others are intermediate. The agouti hairs of the dorsum seem to have a single light band which is subterminal, and are black-tipped. The tail hairs have three or more light bands (as many as five), each generally about three millimeters long. One is subterminal, and proximal to it is a black band which in most individuals is five or more millimeters long. The other dark bands separating light ones are shorter and less black. There is a very small, generally rather inconspicuous, postauricular patch of Light Gull Gray pelage. Legs, feet, and ears are like the back. The tail seems faintly annulated from dorsal view in some specimens, particularly ones with new tail pelage of less than full length. A slight hip mark brightens the dorsal pelage to about Tawny Olive at its juncture with the ventral pelage on the thigh. The immatures, even as

young as MCZ No. 36226, which must have been still a nestling feeding only on milk, are not notably different in color from adults.

*The skull.*—Since the four other, more widespread species and not this one chanced to be examined by Moore (1959, p. 203) for number of transbullar septa and other generic skull characters, it is worth mentioning that in the Museum of Comparative Zoology series of 27 skulls which possess undamaged auditory bullae, all agree with the other species in having a single septum in each bulla. This species, *everetti*, also possesses the other skull characters attributed to the subtribe Callosciurina (Moore, 1959, p. 173). Although the temporal foramen is often small and sometimes absent from one side of the skull in other Oriental long-nosed squirrels, it seems to be entirely absent from skulls of *Dremomys everetti*. The generic character of *Sundasciurus* is produced, according to D. Dwight Davis (in litt.), by inflation of the musculotubular canal where it leaves the auditory bulla anteromesially, and thus constitutes the apparent third division of the auditory chamber, between the forks of the otherwise single transbullar septum. (This is illustrated by Moore, 1959, Figure 1, a.) It is interesting that six of the 27 skulls of *D. everetti* have this canal inflated quite like those in some forms of subgenus *Alelesciurus*.

*Immatures.*—To ascertain which individuals should be considered adult and therefore more likely to be suitable for taxonomic use, comparisons were made within the Museum of Comparative Zoology series. Any individual with deciduous fourth upper premolars present or the sagittal suture still partly open between the parietals was considered immature. In some of the younger of these the third upper molars had not yet erupted to the level of the occlusal plane, and in three there were still sutures evident about the interparietal bone.

In seven of the eight immatures there was a deciduous *third* upper premolar present as well as the fourth. Deciduous third upper premolars have rarely been commented upon in squirrels. Hall (1926, p. 390) has observed this deciduous tooth in the California ground squirrel, *Spermophilus beecheyi*, and comments "the milk tooth is only two-thirds the diameter of the permanent tooth." In *Dremomys everetti* the diameter of the deciduous one measures only 0.2 mm. (with dial calipers under binocular dissecting microscope), whereas the permanent third upper premolars for this series range from 0.8 to 1.0 mm. The deciduous third upper premolar is a slightly curved, slender rod in shape and has a cap of enamel 0.2 mm. or less

in length. None of these deciduous third premolars reaches the occlusal plane and only one reaches more than about halfway from maxillary to occlusal plane.

*Baculum*.—There are a number of bacula preserved with the material of the Museum of Comparative Zoology, and we find that these compare much better with the figures which Pocock (1923, p. 223) gives of *Dremomys* than the one he gives of *Rhinosciurus*. (He shows one for a *Dremomys dawsoni*, incidentally, which may possibly be a misreading of bad handwriting for *Dremomys adamsoni*.)

*Habits*.—This is primarily a ground squirrel which lives in the deep forest of high mountains in northern and western Borneo, and is common between 3000 and 6000 feet elevation but said to be rare at 11,000 feet on Mt. Kinabalu. Places from which it has been reliably reported other than listed above under "material" are Mt. Dulit, Mt. Poi, Mt. Trus Madi, the Kelabit Uplands, and Pamambo Range. Harrison (1954, p. 162) examined stomachs of 26 from Mt. Trus Madi. Five were empty, but from the 21 he found 19 contained insect material, averaging 35 per cent of the contents per stomach. The average amount of fruits and nuts in these was 4 per cent and leaves and shoots 15 per cent. The remainder was "other vegetable material" which he considered probably included bait.

## INDOCHINESE GROUND SQUIRRELS

### Genus **MENETES** Thomas

*Menetes* Thomas, 1908, Jour. Bombay Nat. Hist. Soc., 18, p. 244.

*Type species.*—*Sciurus berdmorei* Blyth.

*Definition.*—The genus *Menetes* is constituted by a single species, *berdmorei*, endemic to the southern part of the Indochinese Subregion and a small part of the Malaysian Subregion just south of the Isthmus of Kra. See Figure 31.

*Diagnosis.*—The genus *Menetes* has several distinguishing characteristics: (1) The upper molars and fourth upper premolar possess extraordinarily high relief, the paracone with the paraloph and the metacone with the metaloph (Bryant, 1945, p. 278) rising high and the central valley sinking especially deep between them so that when the cusps are planed off by wear, the central valley persists filled with dirt and circled by a thin line of enamel. (2) There is one bony septum crossing the chamber of the auditory bulla. (3) The baculum consists of two separate parts, a shaft and a blade. (4) The length of nasal exceeds the least interorbital breadth. (5) The coronoid process of the mandible is poorly developed and only faintly falcate.

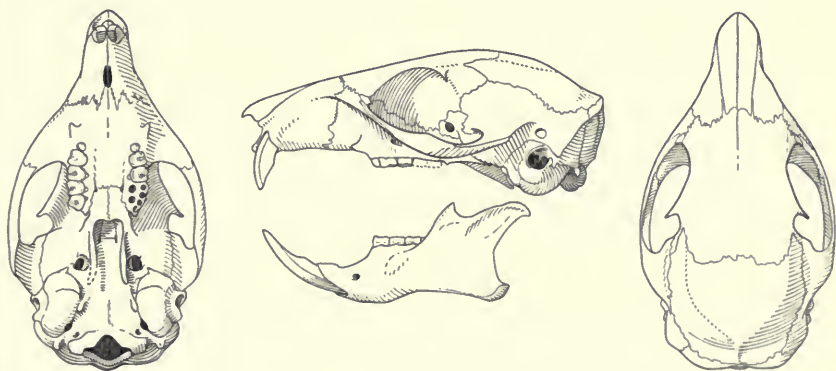


FIG. 30. Skull and left mandible of the Indochinese ground squirrel, *Menetes berdmorei*, AMNH No. 54793,  $\times 1$ . Two left upper molars are missing.



The above characters distinguish *Menetes* from other genera of the Sciurinae in the Indian and Indochinese subregions as follows: from *Ratufa* by 1, 2, 3, 4, and 5; *Funambulus* by 1 and 3; *Callosciurus* by 1, 4, and 5; *Tamiops* by 1, 4, and 5; *Dremomys* by 1 and 5; and *Sciurotamias* by 1, 2, and 5.

*Systematic history.*—Thomas (1914, p. 23) reviewed the species *berdmorei* and recognized five subspecies then constituting the species. In 1918 Robinson and Kloss placed all of the forms then known to belong to the genus *Menetes* in the single species *berdmorei*. Although Zahn (1942, p. 104) relegated *Menetes* to subgeneric rank under *Lariscus*, this was not followed by Ellerman and Morrison-Scott (1951), with whom we agree that *Menetes* is a monotypic genus. There remains primarily the question which of the nine races that Robinson and Kloss recognized in 1918, the ten listed in 1940 by Ellerman, or the six admitted by Ellerman and Morrison-Scott in 1951 can be sustained. The degree of color variation is very limited. The entire genus ranges over a comparatively small area from Mt. Popa in central Burma eastward to Annam and Cochin China, and southward for a short distance down the Malay Peninsula beyond the Isthmus of Kra. In a geographical sense *Menetes* stops where the more southern *Lariscus* begins.

### ***Menetes berdmorei* (Blyth)**

*Definition.*—The species *berdmorei* includes subspecies *berdmorei*, *peninsularis*, *moerescens*, *decoratus*, *consularis* and *mouhottei*, and the named forms included in some of these as synonyms. The range of the species as known to us from specimens is shown in Figure 31.

*Diagnosis.*—Because the genus is monotypic, the diagnosis for the genus fits the species as well.

*Intraspecific variation.*—The most apparent variation in the material of this species is in its black dorsal and lateral lines. While two whitish longitudinal stripes mark each side of this squirrel with great constancy, there may be two or three black stripes on each side and one black middorsal stripe, or some or all of the black stripes may be missing.

By plotting the localities and the months from which the extreme specimens of the whole species were taken, we find the following:

(1) The squirrels without any black lines come preponderantly from the relatively dry, rain-shadow area of middle and northern Thailand.



FIG. 31. Geographical distribution of the Indochinese ground squirrel, *Menetes berdmorei*, as indicated by plotting localities of material examined. Dotted lines separate subspecies on the basis of specimens examined from the plotted localities but are only speculative for any other localities. Between *consularis* and *mouhoti* a considerable area of intergradation is indicated. Subspecies: A, *berdmorei*; B, *peninsularis*; C, *moerescens*; D, *decoratus*; E, *consularis*; and F, *mouhoti*.

(2) The squirrels with all black lines present come preponderantly from mountainous areas which receive the monsoon rains to a greater degree.

(3) In addition to being distributed according to dry and wet geographic areas, these same pattern extremes are evidently varying

TABLE 14. Seasonal variation in occurrence of black stripes within wet and dry geographic areas. 103 specimens of *Menetes berdmorei*.

	No black lines	Blackish lateral	Black lateral	Blackish dorsal	Black dorsal
Dry Geographic Area					
Rainy Season	7	9	3	3	7
Dry Season	25	6	1	2	0
Wet Geographic Area					
Rainy Season	0	0	0	7	13
Dry Season	4	3	2	10	1

to some extent with the wet and dry seasons. In the dry geographic area where most individuals without black lines occur, the available specimens were taken predominantly in the dry season (25 to 7). The majority of those dry area squirrels recorded with some black lines were taken in the rainy season in addition to being taken near the margin of the dry area. In the wet geographic areas where development of black lines predominates, the few specimens having no black lines at all were taken only in the dry season, and those with the quite black middorsal lines were taken almost entirely in the rainy season (13 to 1). See Table 14.

The type of *Sciurus berdmorei* Blyth is lost. The original description by Blyth (1849, p. 603) shows the type to be entirely lacking a black middorsal line. The describer implied that according to his information the type came from the "Thoungyeen district," where the available material from Myawadi and nearby Kaukaryit [Kaw-kareik] also show lack of a black middorsal line. Was Thomas (1914, p. 24) not in error to describe the dry area form as new (*M. b. consularis*) and identify the material of Rangoon, Martaban, and the neighboring wet coastal area with the type of *berdmorei*? Blyth's description of the type fits the third category in Table 14, *i.e.*, black side stripes but no black middorsal. Thomas' interpretation (*op. cit.*, p. 23) would put it in the fifth category, *i.e.*, possessing black side lines and black middorsal line. Blanford's (1878, p. 162) delineation of the Myawadi and Kawkareik material places them in the first and second categories of Table 14, *i.e.*, having no black stripes. Only the type of *berdmorei* was, therefore, intermediate between the characteristic pelage of the subspecies of the coastal area and that of the inland subspecies of northern Thailand. It was also more closely associated geographically with material which Blyth's description identifies with the inland form. Were the designation of the type

locality less inclusive and vague, this would necessitate applying the name *M. b. berdmorei* exclusively to the subspecies now known as *M. b. consularis*. If the dark-lined coastal form does take its mid-dorsal stripe into some part of the Thaungin River Valley, it can be argued that Berdmore may (or must) have obtained the type from that part.

See Table 15 for an indication of the body and skull dimensions of the species *berdmorei*.

### **Menetes berdmorei berdmorei** (Blyth)

*Sciurus berdmorei* Blyth, 1849, Jour. Asiatic Soc. Bengal, 18, p. 603.

*Lariscus berdmorei amotus* Miller, 1914, Smithsonian Misc. Coll., 61, no. 21, p. 24.

*Types*.—*Sciurus berdmorei* (lost), from Thoungyeen District, Tenasserim, collected by Captain Berdmore; *amotus*, USNM No. 124152, adult male, from Domel Island, Mergui, collected January 30, 1904, by W. L. Abbott.

*Material examined*, from peninsular Thailand.—Klong Ban Lai [Ban Salui], Patiye (BM), two; Koh Lak [Prachuap Khiri Khan], sea level (BM), one.

*Material examined*, from Burma.—Kau Karyil, Houg Thrau [Haung Tharaw] River (BM), one; Bankachon, V.P., south Tenasserim (BM), one; Sullivan's I. (BM), one; Thaget, Little Tenasserim River (BM), one; Banlaw, Great Tenasserim River (BM), one; Kissieraing I. [Kissaraing or Kittha-reng], 50 feet (BM), one.

*Original description*.—"Nearly one half larger than [*Funambulus palmarum*]: the prevalent colour grizzled black and golden fulvous, with an obscure pale central dorsal streak, flanked by a blackish band: this again by a conspicuous yellowish-white line from the shoulder to the croup; then blackish again, with a second lateral whitish band; below again dusky; and the underparts yellowish white, passing to ferruginous towards the vent and underneath the tail. Head tinged with ferruginous: . . . This species, according to information received from D. F. Lonsdale, inhabits the Thoungyeen district [Thoungyin River]."

*Habits*.—One collector makes the following field observations: "This species spends most of its time on the ground, occasionally it may be seen running along railings or up and down slanting or broken bamboos, but never at any distance from the ground. At Bankachon it is said to be often found on the edges of rice fields,



TABLE 15. Dimensions of Some Type Specimens of the Genera *Menetes* and *Sciurotamias*. (The first seven of these types belong in the species *M. berdmorei*, the next three in *S. davidianus*, and the last in *S. (Rupestes) forresti*.)

NAME	BODY			SKULL						
	Head & Body	Tail	Hind Foot	Total Length	Mas-toid Breadth	Length Nasals	Dia-stema	Length Palate	Length Bulla	Maxillary Tooth row
<i>amotus</i>	200	130	43	51.5	20.6	15.8	13.4	28.0	8.8	9.4
<i>peninsularis</i>	196	149	46	49.2	19.7	15.1	12.7	26.1	8.7	9.0
<i>moerescens</i> <sup>1</sup>	210 ±	130 ±	43	....	21.8 ±	16.2	11.5	26.1	8.2	9.5
<i>decoratus</i>	188	175	43	48.7	20.2	14.8	12.9	26.5	8.8	9.0
<i>consularis</i> <sup>1</sup>	179	151	44	....	20.2	14.6	12.9	26.3	9.6	8.3
<i>mouhotiei</i>	200 ±	130 ±	46	....	....	16.0	14.3	27.2	...	8.2
<i>koratensis</i>	160 ±	90 ±	41	46.7	19.0	14.0	12.7	25.7	9.4	8.4
<i>davidianus</i>	200 ±	155 ±	54 ±	55.8	23.0	19.3	12.5	27.6	12.0	9.0
<i>oustoni</i>	190	165	52 +	....	....	16.6	12.8	26.1	...	9.2
<i>thayeri</i>	215	148	58	56.0	22.4	17.2	13.0	28.5	10.7	9.0
<i>forresti</i>	224	166	57	....	23.1	19.6	15.5	30.8	11.3	8.7

<sup>1</sup> The types of *moerescens* and *consularis* are young adults.

around Maliwun it was occasionally seen running across tracks and among long grass, and bamboo scrub, especially in the early evenings, but I have also seen it in the thickest forest. It is very like *Tupaia* in its movements, hiding at the smallest noise and not readily making a second appearance. Weight— $7\frac{1}{2}$  ozs." (G. C. Shortridge in Wroughton, 1915b, p. 713)

### **Menetes berdmorei peninsularis** Kloss

*Menetes berdmorei peninsularis* Kloss, 1919, Jour. Nat. Hist. Soc. Siam, 3, p. 375.

*Type*.—BM No. 26.10.19.5, adult male, from Ban Koh Klap [Ban Na], Nakon Sritamarat [Nakhon Si Thammarat], near Bandon, peninsular Thailand, collected July 3, 1913, by H. C. Robinson and Cecil B. Kloss.

*Material examined*.—Kampenpet [Ban Kamphaeng Phet, latitude  $7^{\circ} 11' N.$ ], Thailand (BM), one.

Although the type was described as having the median and lateral black lines strongly marked, it has been previously pointed out (Robinson and Kloss, 1915, p. 121) that the *Menetes* from elsewhere (Bandon) are extremely variable in this respect.

### **Menetes berdmorei moerescens** Thomas

*Menetes berdmorei moerescens* Thomas, 1914, Jour. Bombay Nat. Hist. Soc., 23, p. 24.

*Type*.—BM No. 6.11.6.32, young female from Bali, near Nhatrang, latitude  $12^{\circ} N.$ , south Annam.

*Material examined*.—Kontoum [also, Kon-toum and Kontum], Annam (MNHN), two, (BM), 4; Dak-To [also Dak-to], Annam (MNHN), one, (BM), two; Ban Me Thuot [Buon Ma Thuot], Annam (CNHM), four; "Eaktur," E. of Ban Me Thuot, Annam (CNHM), two; Ninh Hoa, Annam (CNHM), one.

*Original description*.—"Markings about as in *decoratus*, but less conspicuously contrasted, owing to general body colour being darker and duller, more olive brown, underside and tips of tail hairs yellowish. Size rather larger than in other forms. Muzzle of skull unusually slender."

### **Menetes berdmorei decoratus** Thomas

\* *Menetes berdmorei decoratus* Thomas, 1914, Jour. Bombay Nat. Hist. Soc., 23, p. 23.

*Type*.—BM No. 14.4.3.4, old female, from Mt. Popa, south central Burma, below 4000 feet, collected April 20, 1913, by G. C. Shortridge.

*Material examined*, all from Burma.—Mt. Popa, 4961 feet (BM), eight; Mt. Popa (AMNH), five, (CNHM), two (topotypes); Pegu Yoma Range, north of Rangoon (AMNH), eight; North Zamayi Res., 70 miles north of Pegu, 700 feet (BM), one; South Zamayi Res., 60 miles north of Pegu, 500 feet (BM), one; 30 miles N.W. of Toun-goo, Burma (CNHM), two.

*Original description*.—"Median dorsal and upper lateral dark streaks prominent, all the markings very strongly defined, the main dark lateral band broad and glossy black; an additional blackish streak edging the belly; general body colour clear grizzled olive, undersurface and tips of tail hairs pure white."

*Discussion*.—A glance at the map shows that the Pegu Yoma range is a southward extension from the prominent Mt. Popa. Specimens from these mountains tend to have the black striping heavily accentuated. It appears likely that the present race *decoratus* is bounded on the west by the Irrawaddy River and on the east by the Salween River. Eastward beyond the Salween the relatively less striped race *berdmorei* occurs.

Intensification of the black striping recurs elsewhere only in *pen-insularis* and *moerescens*, both of which are from mountainous regions of heavy rainfall.

*Habits*.—This form has been observed in the field and commented upon as "Occurring on Mt. Popa among rocks and stones, that are surrounded by thick scrub, and often close to cultivation, up to 4,000 feet. Very shy, running into holes and crevices at the slightest sound or movement. It is essentially a ground squirrel, seldom, if ever, ascending trees, though by no means confining itself to open country." (G. C. Shortridge, in Wroughton, 1915a, p. 474)

### **Menetes berdmorei consularis** Thomas

*Menetes berdmorei consularis* Thomas, 1914, Jour. Bombay Nat. Hist. Soc., 23, p. 24.

*Type*.—BM No. 2.6.6.6, young female, from Nan [Muang Nan], 200 meters, Siam, collected October 6, 1901, by T. H. Lyle.

*Material examined*, from Thailand.—"Kowpla," Paknampho [*Ban Pak Nam Pho*], Nakonsawan (USNM), one; Airawan Mtn. [Khao Erawan], Lop Buri (USNM), one; Mt. Angka [Doi Inthanon], 4300 feet [1310 meters] (MCZ), six, (CNHM), one; "central Siam"

(MCZ), one; Doi Nangkeo [Doi Phi Phan Nam] (MCZ), two; Chien-grai [Muang Chiang Rai] 410 meters (BM), three; "Tahkamen" [west of Bangkok] (BM), one; halfway between Pichet [Ban Nai Muang] and Paknampo [Ban Pak Nam Pho], 33 meters (BM), one; 100-125 miles north of Bangkok, 20-25 meters (BM), two; "Nam Phi" *Nan*, 225 meters (BM), one; Nakon Sawan [Nakhon Sawan], 29 meters (BM), one; Me Wong (river), 53 miles east of Um Pang [Ban Le Kathe] (BM), three, (AMNH), three; Koon Tan [Doi Kuhn Tan, or Sathani Kuhn Tan] (NR), one; Chum Poo [Sathani Tha Chomphy] (NR), one; "Vieng Nun," northern Siam (NR), one; Muang Prom [Muang Phrom Buri] (BM), two; Me Ping River (AMNH), one; below Paknampo [Ban Pak Nam Pho], 26 meters (BM), one; Melamoung [Me Lamung] (AMNH), one; north of Raheng [Ban Rahaeng] (NM), one; Raheng [Ban Rahaeng], 120 meters (BM), one; Sokotai [Ban Thank], 64 meters (BM), one; 20 miles west of Kempnanpet [Changwat Kamphaeng Phet] (AMNH), one.

*Material examined*, from Burma.—Taok, Thuaungyin Valley [Thaungyin Valley], 1100 feet (BM), one; Myawadi [Mya Wadi], Tenasserim (BM), two; Kawkereik [Kawkaeik], Tenasserim (AMNH), one.

*Original description*.—"No median dorsal stripes or upper dark lateral ones, the only dark streak being that between the light lateral streaks, and even this is absent in January and February. Under surface yellowish white."

### **Menetes berdmorei mouhotei (Gray)**

*Sciurus mouhotei* Gray, 1861, Proc. Zool. Soc. London, 1861, p. 137.

*Sciurus pyrrhocephalus* Milne-Edwards, 1867, Rev. Mag. Zool. (ser. 2), 19, p. 225.

*Meneles berdmorei koratensis* Gyldenstolpe, 1917, Handl. K. Svenska Vetensk. Akad., 57, no. 2, p. 39.

*Types*.—*Sciurus mouhotei*, BM No. 61.4.12.13, from Cambodia; *pyrrhocephalus*, MNHN No. 1864-682, adult female, collected in Saigon, Cochin China, by Rudolphe Germain; *koratensis*, NR No. 4, adult male, from Sakerat [Ban Chakkrarat], east Siam, collected January 9, 1912, by Nils Gyldenstolpe.

*Material examined*, from Thailand.—"Khow Wing," Siracha [*Ban Si Rachal*], Chonburi (USNM), one; Satahip (Ban Sattahip), sea level (BM), one; Chantabun [Chanthaburi] (USNM), four, (AMNH), four;



Klong Yai (BM), two, (USNM), three; Lem Ngop [Ban Laem Ngop] (BM), three, (USNM), one; Ok Yam [Ok Pyam] (BM), one, (USNM) three; Koh [Ko] Kut I. (USNM), six, (BM), six; Koh [Ko] Chang I. (BM), one, (USNM), two; Sriracha [Ban Si Racha] (USNM), three, (CNHM), one; Hup Bum [Ban Hup Bum], 500 feet (152 meters) (BM), two; Ban Sadet [Ban Phan Sadet] near Sriracha (USNM), one; Nonokhor [Ban Nong Kho], near Sriracha (USNM), one; "Nong Mong," Muong Karbin [*Ban Kabin Buri*] (USNM), one, (BM), one; Kao Sabab [Khao Sa Bap] (USNM), one; Pak Jong [Ban Pak Chong] (USNM), one, (AMNH), three, (MCZ), one; Aranya [Ban Aranya-prathet] (USNM), one; Lat Bua Kao [Ban Lat Bua Khao] (USNM), six; Sakarat [Ban Chakkrarat] (NR), one; 50 miles south of Bangkok, seacoast (BM), two.

*Material examined*, from Indochina.—Plateau Bolovens, Laos (AMNH), one; An-Bierh [An Binh] (BM), one; Honquan [Hon quan] (BM), two, (CNHM), one; Phu-Quoc I. (BM), one; Tay ninh, 100 feet (30 meters) (BM), two; Lagna River (AMNH), one; Dinquan [Din Quan] (USNM), one; "Cambodia" (BM), two; Siem-Reap [Siem reap] (MNHN), one; Angkor, 150 feet (46 meters) (BM), one; Cam Chay [Kam Chay] Mts. (BM), two.

*Original description*.—"Grisled grey-brown, with pale rings; lips, chin, throat, and under side of body and inside of limbs white; upper part of the sides with a longitudinal black streak, edged above and below with a narrow white line; tail blackish, whitish washed, hairs elongate, brown, with two broad black rings and a white tip. . . ."

*Habits*.—Little seems to be known about the natural history of *Menetes*. Gyldenstolpe (1914, p. 15) makes an interesting comment, which in his experience appears to apply to this form and *consularis*. "This species was very common in the dry forests both in Northern and Eastern Siam. It was always observed near the villages, or in the compounds in the towns, but never far into the jungles."

## CHINESE ROCK SQUIRRELS

### Genus **SCIUROTAMIAS** Miller

*Sciurotamias* Miller, 1901, Proc. Biol. Soc. Washington, **14**, p. 23.

*Rupestes* Thomas, 1922, Ann. Mag. Nat. Hist. (ser. 9), **10**, p. 398.

*Type species*.—*Sciurotamias*, *Sciurus davidianus* Milne-Edwards;  
*Rupestes*, *Rupestes forresti* Thomas.

*Definition*.—The genus *Sciurotamias* is constituted by the two monotypic subgenera *Sciurotamias* and *Rupestes*, both endemic to northern China.

*Diagnosis*.—(1) There are two dorsal processes on the zygomatic process of the squamosal. (2) The ectopterygoid ridge of the alisphenoid is obsolescent. (3) The upper incisors are strongly opisthodont. (4) Three bony septa cross the chamber of the auditory bulla.

The above characters all distinguish *Sciurotamias* from each of the other genera of the Sciurinae of the Indian and Indochinese subregions.

### Subgenus **SCIUROTAMIAS** Miller

*Sciurotamias* Miller, 1901, Proc. Biol. Soc. Washington, **14**, p. 23

*Type species*.—*Sciurus davidianus* Milne-Edwards.

*Definition*.—The subgenus *Sciurotamias* includes only the type species *davidianus*, a polytypic, montane, ground squirrel of northern China.

*Diagnosis*.—The subgenus *Sciurotamias* apparently may differ from subgenus *Rupestes* in several notable characters: (1) The squamosal is high. (2) The zygoma ascends to a point well above halfway on the height of the rostrum. (3) The superior process of the jugal is very low and anterior to the midlength of the orbit. (4) There is no pronounced temporal ridge. (5) The postorbital process of the frontal is more than 2 mm. long. (6) There is a peg-shaped third upper premolar. (7) There are generally faint whitish postauricular streaks on the pelage but no whitish longitudinal stripes on the sides of the body.

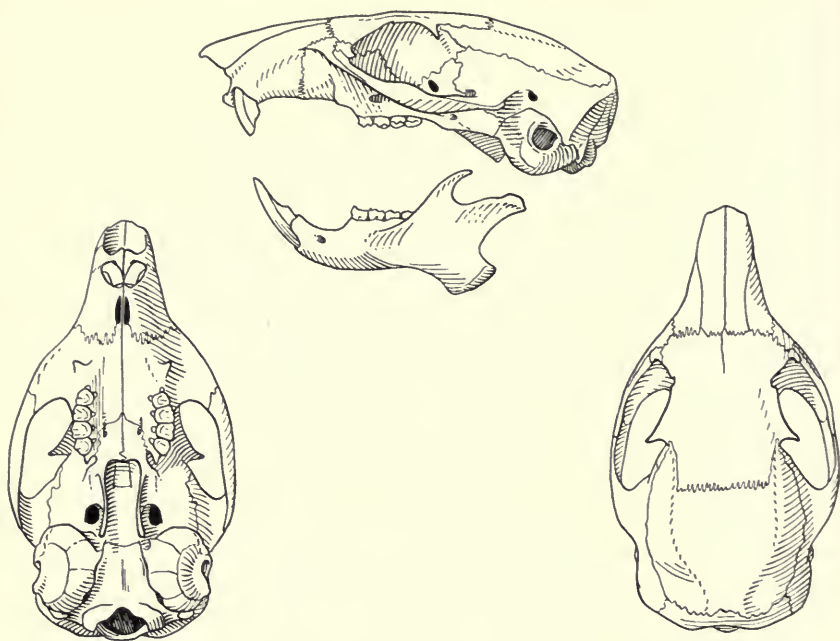


FIG. 32. Skull and left mandible of the montane rock squirrel of China, *Sciurotamias davidianus*, AMNH No. 45370,  $\times 1$ . Note indications of the three transbullar septa which distinguish this genus from the Oriental tribe Callosciurini and the Holarctic tribe Scurini as well.

### ***Sciurotamias davidianus* Milne-Edwards**

*Definition.*—The species *davidianus* is composed of subspecies *davidianus* and *consobrinus*, which include several named forms here as synonyms. The geographic distribution known to us from specimens examined is shown in Figure 33.

*Diagnosis.*—Since the subgenus is monotypic, the diagnosis of the species is identical to that for the subgenus.

*Relationships to other species.*—*Sciurotamias* is said to inhabit cliffs and rocky ground of the mountains avoiding trees, and nesting in deep crevices. It would be interesting to know the extent to which it differs from *Dremomys p. pyrrhomerus* in habitat. The two seem not to have been collected at the same localities; although their ranges appear to be closely approximated. G. M. Allen (1940, p. 646) has stated that *Dremomys* is arboreal in contrast to *Sciurotamias*, but he evidently inferred this from *Dremomys* being taken in deep forest. References to its habits in Malaya and Borneo indicate that



FIG. 33. Geographic distribution of the Chinese rock squirrel, *Sciurotamias davidianus* (round symbols), and Chinese cliff squirrel, *Sciurotamias (Rupes) forresti* (square symbols), as revealed by plotting the collecting localities of material examined. Subspecies of species *davidianus*: A, *davidianus*; B, *consobrinus*.

it inhabits forested areas of mountains, but is primarily terrestrial there. In 1934, at a single locality in the mountains 25 miles west of Wenchwan, Szechwan, T. Donald Carter collected *Dremomys pernyi* and *Sciurotamias d. consobrinus*. Since this is the only place which we have located where both of these species are known to have been collected, his comments on their habitats seem especially significant. He recalls clearly (September 1956) in conversation over the collected material laid before him, that the *Dremomys pernyi* inhabited the steep, forested slope of the narrow valley of Chengou Creek, and he recalled them particularly in the second growth near



the foot of the slope where there had been some removal of timber. They did ascend trees, he said, but seemed to be on the ground a good deal, and he collected them on the ground, particularly among moss-covered logs of down timber. The *Sciurotamias* lived in small areas of rather level, boulder-strewn grassland where the narrow valley bottom widened out occasionally. There were no trees on this, and *Sciurotamias* lived here like a ground squirrel. The treeless character of these level areas along the creek bottom Mr. Carter attributed to perhaps seasonal flooding by the torrential mountain stream.

The evidence presented in the accompanying maps shows that the ranges of both *Dremomys pernyi* and *Dremomys pyrrhomerus* lie to the south of the distribution of *Sciurotamias davidianus* (excepting for the isolated example of the latter from Hwangtsaopa, Kweichow). The above example of apparently sharp segregation into two very different biotic communities in an area of overlap of species range, may not, however, be a fair indication of the variety of habitat utilized by either species in the parts of its range which are not shared with closely related species.

It may be worth noting in this connection that the distribution of *Sciurotamias davidianus* shown here coincides with the long northeast to southwest portion (but not the southeast) of the "Deciduous broad-leaved forest predominated by deciduous oaks" mapped by Wang (1956, p. 513) and that that of *S. forresti* lies in an area in which Wang shows two alternating vegetation types: 1. Tundra and alpine vegetation, and 2. Montane coniferous forest predominated by spruce and fir. *Dremomys p. pyrrhomerus* occurs south of this in the area that Wang maps as "Evergreen broad-leaved forest of evergreen oaks, shima, and laurels, with [pines] in secondary stands." *D. p. pernyi* is sympatric with *S. forresti* but apparently allopatric with *S. davidianus*. *D. p. flavior* is allopatric with *D. p. pyrrhomerus* but occupies a more western part of the evergreen broad-leaved forest area as mapped by Wang.

Although *Sciurotamias* is as long-snouted proportionately as *Dremomys lokriah*, for example, a skull of *Sciurotamias* is readily distinguished from those of *Dremomys* species by being broader, arched, and flattened, so that it is shaped quite like skulls of the chipmunk, *Eutamias*. The posterior upper premolar is notably smaller than any of the upper molars in *Sciurotamias* whereas in *Dremomys*, its size does approximate that of one or more of the molars. The foramen ovale is circular in *Sciurotamias*, narrowly oval in *Dremomys*.

*Sciurotamias* has three bony septa across the chamber of the auditory bulla; whereas members of the tribe Callosciurini have one or none. The upper incisors are strongly opisthodont in *Sciurotamias*; whereas those of members of the Callosciurini are orthodont or, more frequently, proödont (defined in Moore, 1959, p. 162). *Sciurotamias* differs also in having cheek pouches.

See Table 15 for an indication of the body and skull dimensions of species  *davidianus*.

### ***Sciurotamias davidianus davidianus* (Milne-Edwards)**

*Sciurus davidianus* Milne-Edwards, 1867, Rev. et Mag. Zool. (ser. 2), 19, p. 196.

*Dremomys latro* Heude, 1898, Mem. Hist. Nat. Chinois, 4, pt. 2, pp. 54-55.

*Types*.—*Sciurus davidianus*, MNHN No. 1863-655, collected by Père Armand David in the "mountains of Peking," Hopei, China; *latro*, not seen, but thought to be from Shantung, China (Allen, 1940, p. 662).

*Material examined*, from Hopeh, China (except as noted).—"Chihli" (NR), 15; near Ching Wang Tas [Chinwangtao] (USNM), 11; Hsin-lung-shan, 65 miles N.E. of Peking [Jehol, Manchuria] (USNM), two; Wu-ting-shan, 75 miles N.E. of Peking [Jehol, Manchuria] (USNM), two; Western Hills, 15 miles W. of Peking (USNM), one, (RNH), one; Tung-ling (USNM), one, (AMNH), three, (CNHM), four; Eastern Tombs (AMNH), three, (CNHM), one.

*Material examined*, from Shansi, China.—Mts. 50 miles N.W. of Tai-yuan-fu [Yangku] (USNM), four; Mts. 10 miles S. of Wu-tsai [Wutai] (USNM), one; Mts. 70 miles N.N.W. of Tai-yuan-fu [Yangku] (USNM), three; "He-shuin" (MCZ), one; "Sjol" (NR), five.

This subspecies is distinguished from the southern race by its lighter, grayer dorsal color, about Deep Grayish Olive, and by its grayish instead of buffy-brownish under parts. The race is apparently confined to territory north and east of the Hwang-Ho River. The postauricular patches appear to be less prominent in this race, and the posterior streaking from them, mentioned above, is evident less frequently.

We follow Allen (1940, p. 662) in synonymizing *latro* with *davidianus*.

### ***Sciurotamias davidianus consobrinus* (Milne-Edwards)**

*Sciurus consobrinus* Milne-Edwards, 1868-74, Recherches pour servir a l'Hist. Nat. des Mammifères, p. 305.

*Dremomys collaris* Heude, 1898, Mem. concern. l'Hist. Nat. de l'Emp. Chinois, 4, part 2, p. 55, pl. 12, figs. 2-2c.

*Dremomys saltitans* Heude, 1898, Mem. concern. l'Hist. Nat. de l'Emp. Chinois, 4, part 2, p. 55, pl. 12, figs. 4-4c.

*Sciurotamias owstoni* J. A. Allen, 1909, Bull. Amer. Mus. Nat. Hist., 26, p. 428.

*Sciurotamias davidianus thayeri* G. M. Allen, 1913, Mem. Mus. Comp. Zool., 40, no. 4, p. 231.

*Types*.—*Sciurus consobrinus*, not found at MNHN, a specimen from Muping, Szechwan, China, collected by Père Armand David; *collaris*, not seen, possibly at the Sikawei Museum in Shanghai, China; *saltitans*, not seen, possibly at the Sikawei Museum in Shanghai, China, thought to have been taken in Hupeh Province, China (Allen, 1940, p. 665); *owstoni*, AMNH No. 27545, an adult female from Si-Tai-pa-shieng Mts., Shensi, China, taken in October 1905 by A. Owston; *thayeri*, MCZ No. 8008, an adult male from Washan, 6000 feet, Szechwan, China, taken May 17, 1908, by Walter R. Zappey.

*Material examined*, from Shensi, China.—Tai-Pa-Shiang Mts., 6000 feet (AMNH), eight; Tai-pei-shan Dist., 3000 feet, 80 miles W.S.W. of Sian-fu [Siking] (USNM), three; base of Tai Pei Shan, Tsingling Mts. (CNHM), six; 15 miles east of Yen-an-fu Fushih (USNM), one; Tsingling Mts. (AMNH), three, (MCZ), one, (CNHM), six; 45 miles south of Fensiangfu, 3000 to 3600 feet (AMNH), two, (MCZ), one, (CNHM), two; nine and 15 miles south of Ching-chien-hsien, 2600 feet (USNM), two; Liu-tsuen, 1500 feet, 15 miles south of Sian-fu (USNM), four.

*Material examined*, from Kansu, China.—Ha Tebbuland, 8500 feet, Wantsangku (MCZ), three.

*Material examined*, from Hupeh, China.—Ma Fu Ling, 5000 feet (MCZ), two; Hsien Shan Hsien, 4000 feet (MCZ), two; "Tan Sweo Nah," 3000 feet (MCZ), one; Fongshan [Fanghsien] (MCZ), one; "Moo Swei Ping" (MCZ), one.

*Material examined*, from Honan, China.—"Honan" (NR), three.

*Material examined*, from Szechwan, China.—"Lu Din Chiao," 5000 feet (USNM), one; Longpan [Sungpan] (USNM), one; near Weichow [Weikiu], 9000 feet (USNM), one; "Tu-pa-keo," Moupine [Muping] (CNHM), one; Wenchuan [Wenchwan] (USNM), 19, (AMNH), 24; Mt. Omei (USNM), two; E. of Romitchangu (MCZ), one; Ko-chia-ho-pa, 7500 feet (CNHM), one; Trash-cho-ten, 8250 feet (CNHM), one; WaShan (MCZ), one; "Nai Su Chen" (CNHM), one; "Goan Shih Dwe" (CNHM), four; "Sungpan" (CNHM), two.

*Material examined*, from Kweichow, China.—Whang Tsao Pa [Hwangtsaopa] (USNM), one.

*Discussion.*—We have been unable to distinguish any really good characters to separate *consobrinus*, *owstoni* and *thayeri* from one another. Taken together they are darker and more brownish, Cinnamon Brown to Mummy Brown, than the northern race *dauricus*, and their under parts have a wash of Light Ochraceous Buff to Ochraceous Buff which is lacking in the gray-bellied *dauricus*. In the series of *consobrinus* from Wenchwan, the white postauricular patches are prominent.

It is rather remarkable that a specimen should come from very southern Kweichow over 300 miles south of other *Sciurotamias d. consobrinus* locations found. In this hiatus, moreover, are a number of localities where *Dremomys pernyi* and *D. pyrrhomerus* were taken.

*Habits.*—Fu (1936, p. 258) makes an interesting comment on the habits of this squirrel in western Honan where he collected it in the Sung-shan: "This animal nests in the ground, and is ascribed as a nuisance to peasants on account of its damage on corns. The den and its contents are often destroyed by ploughing."

### Subgenus RUPESTES Thomas

*Rupestes* Thomas, 1922, Ann. Mag. Nat. Hist. (ser. 9), 10, p. 398.

*Type species.*—*Rupestes forresti* Thomas.

*Definition.*—The subgenus *Rupestes* includes only the one species *forresti*, which is a relict known only from the mountains of western China as shown in Figure 33.

*Diagnosis.*—(This diagnosis is based upon one skull of a subadult with the occiput and bullae missing, USNM 255138, and four skins.) On the evidence examined *Rupestes* differs from subgenus *Sciurotamias* in several notable characters: (1) The squamosal reaches up the side of the cranium less than halfway from the base of the zygomatic process to the base of the postorbital process. (2) The anterior edge of the zygoma ascends to a point only halfway in the height of the rostrum. (3) The superior process of the jugal is high and posterior to the midlength of the orbit. (4) There are pronounced temporal ridges. (5) The postorbital process of the frontal is very short (less than 1 mm. in this specimen). (6) There are no third upper premolars. (7) There is a rather faint light stripe along the flank between shoulder and hip.

### *Sciurotamias (Ruppestes) forresti* (Thomas)

*Rupestes forresti* Thomas, 1922, Ann. Mag. Nat. Hist. (ser. 9), 10, p. 399.



*Type*.—BM No. 22.9.1.54, old female, from Mekong-Yangtze divide, latitude  $27^{\circ} 20' N.$ , 7000 to 9000 feet, northern Yunnan, China, collected June 5, 1921 by George Forrest.

*Material examined*.—E. of Yalung [River], 15,500 feet [4725 meters], Szechwan [Sikang] (USNM), one; Chienchwan [Tienchüan], Szechwan [Sikang] (MCZ), one; LiChiang [Likiang], Yunnan (AMNH), one, (BM), one; Mekong-Yangtze divide latitude  $27^{\circ} 20' N.$ , 7000 to 9000 feet, Yunnan (BM), two.

*Definition*.—This relict, rarely taken species is apparently monotypic, and its range as known from four specimens examined is shown in Figure 33.

*Diagnosis*.—Since the subgenus is monotypic, the diagnosis of the subgenus serves for the species.

This species is readily told from *dauidianus* by the presence of a pair of faint whitish lines high on the sides which extend from the shoulders to the hips. These lines are edged on each side by the dark grizzled dorsal coloring. Some 6 mm. beyond them the dark dorsal color changes to the light orange brown of the sides and that in turn to the buffy of the underparts.

See Table 15 for some dimensions of the type.

## SUMMARY

Twenty-six species of the seven genera of Sciurinae occurring in the Indian Subregion and Indochinese Subregion of the Oriental Region are, for these geographic areas, here fully revised. Since four of the seven genera (*Funambulus*, *Tamiops*, *Menetes*, and *Sciurotamias*) are endemic, complete generic revisions of these are presented. In order to offer a complete revision of the genus *Dremomys*, also, the one extraterritorial (monotypic, Malaysian) species, *everetti*, is included here. Eight species of *Callosciurus* are recognized in the Indochinese Subregion, and are shown to constitute two superspecies which are broadly sympatric throughout much of the subregion. These two superspecies are observed to form a phylogenetic unit separate from the Malaysian species of *Callosciurus*, and a complete revision is offered for this eight species unit. In the genus *Ratufa* complete revision is presented for the two species in the Indian Subregion. The species *Ratufa bicolor* which occurs throughout much of the Indochinese Subregion is revised only for this area, although it also has an extensive distribution in the Malaysian Subregion.

The principal changes from earlier existing concepts are within the Indochinese subregional unit of the genus *Callosciurus*, a unit previously unrevised. Considerable advancement in clarification and improvement of previously existing knowledge, however, is provided for every species by mapping the distribution of collecting localities. Future supplementation and correction of the present knowledge is made easy by presenting latitudes and longitudes for the collecting localities presumed found. In those subspecies for which adequate material was examined, particularly in American museums, descriptions are provided from large samples in effort to make them applicable to the populations (not merely the type specimens) involved. In the genus *Callosciurus* in particular, perhaps only because more collecting sites and materials are known, striking evidence is present in the taxonomic account of inability to cross the main courses of the great rivers of the subregion. The evolutionary implications of this and other facts of geographic distribution of diurnal squirrels in this subregion are only sparingly discussed.



## GAZETTEER

It is intended in any discussions in the present paper to employ the geographic names current at the time of final preparation of the manuscript. In the lists citing localities where specimens were collected, however, the names and spellings that were recorded on the original specimen tag by the collector have ordinarily been retained. Should any question arise, this permits reinterpretation of the locality without resort to the original source. The currency of geographic names of the smaller principalities actually used here necessarily varies a great deal, depending upon the source. For some localities no knowledge is available to us except that they are villages near which specimens were taken, and they are mapped in an account of a collecting trip. Many, however, were taken by collectors whose routes and collecting localities were not published and whose localities to be plotted must usually be found on some map. Since villages in the jungle are often moved, localities of 50 years ago may be in many cases more easily found on maps made about that time.

Many sources were utilized, but those most helpful and employed most were: Stanford (1917) "Complete Atlas of China" with maps at scale of 1:3 million; a set of maps of Indochina and most of Thailand at 1:1/2 million published at Luang Prabang in 1931 by le Service Geographique de l'Indochine; "The Times Survey Atlas and Gazetteer of the World," J. G. Bartholomew (1922); its successor, "The Times Atlas of the World, Mid-Century Edition," John Bartholomew (1958); and maps published by the National Geographic Society, Washington, D. C.

Because villages are moved and the names of towns, cities, and even natural geographic features, have been changed by new political regimes, latitude and longitude (from the Greenwich zero meridian, NOT the Paris one of the map of Indochina cited above) are employed. Even this effort at accuracy embraces errors of five miles or so from differences of latitude or longitude between different maps. This may be a matter of some concern in the immediate vicinity of a large river which is potentially an important, long-time barrier to the species.



In alphabetizing, place names of more than one word are treated as if but a single word (*e.g.*, Ban Don, Bangnara, Ban Huai Som would come properly in this order).

Occasionally place names are used that may be found on a good map in several places (*e.g.*, Khao Soi Dao is the name of at least three mountains in Thailand). With the knowledge from the specimen tag of who collected the specimen and when, and with available knowledge of the collector's itinerary, we have generally been able to decide which must be the correct place. In the gazetteer, only if specimens here studied were collected at two localities of the same name is an effort made to warn the user of the existence of other like place names.

- ADUNG VALLEY, Burma: 28° 10' N., 97° 40' E.  
 AGIA, Assam, India: 26° 06' N., 90° 34' E.  
 AINGGYI, Pakokku Chin Hills, Burma: 21° 05' N., 94° 22' E.  
 AIRAWAN, MT.: *see* Khao Erawan  
 AKHE TRIANGLE, Upper Burma: 26° 54' N., 98° 12' E.  
 AKOLA, Berar, India: 20° 45' N., 77° 00' E.  
 AMARAKANTAK, India: 22° 40' N., 81° 45' E.  
 AMHERST, Tenasserim, Burma: 16° 00' N., 97° 38' E.  
 AMLEKHGANJ, Nepal: 27° 18' N., 85° 00' E.  
 AMRAOTI, Bastar [Berar], India: 20° 55' N., 77° 50' E.  
 AN BINH, Cochinchina, Viet Nam: 10° 30' N., 106° 43' E.  
 ANGKOR, Cambodia: 13° 25' N., 103° 50' E.  
 ANGTONG [Ang Thong]: *see* Ban Bang Kaeo  
 ARANYA: *see* Ban Aranyaprathet  
 ARBRE BROYE, Viet Nam: 11° 57' N., 108° 28' E.  
 AVALANCHE, Nilgiri Hills, India: 11° 10' N., 76° 35' E.  
 AYUTHIA: *see* Phra Nakhon Si Ayutthaya  
 BAC KAN, Tonkin, Viet Nam: 22° 10' N., 105° 45' E.  
 BAC TAN TRAY, Tonkin, Viet Nam: 22° 06' N., 103° 15' E.  
 BAKSA, Formosa, China: 23° 10' N., 120° 29' E.  
 BALAPALLI, Madras, India: 13° 45' N., 79° 35' E.  
 BALI: *see* Nhatrang  
 BAMANIGAON, Assam, India: 26° 10' N., 91° 25' E.  
 BA NAM CHI, Tonkin, Viet Nam: 22° 07' N., 102° 56' E.  
 BA NAM NHUNG, Tonkin, Viet Nam: 22° 07' N., 103° 00' E.  
 BAN ARANYAPRATHET, Prachin Buri, Thailand: 13° 40' N., 102° 30' E.  
 BAN BANG KAEO, Ang Thong, Thailand: 14° 35' N., 100° 25' E.  
 BAN CHAKKRARAT, Nakhon Ratchasima, Thailand: 15° 00' N., 102° 25' E.  
 BAN CHANG THUK, Thailand: 14° 45' N., 101° 30' E.  
 BAN CHIANG DAO, Thailand: 19° 20' N., 99° 00' E.  
 BAN CHOENG DOI, Chiang Mai, Thailand: 18° 50' N., 99° 10' E.  
 BAN DEN, Nong Khai, Thailand: circa 18° 00' N., 102° 55' E.  
 BAN DOI SAKET: *see* Ban Choeng Doi  
 BANDON: *see* Ban Makham Tia

- BAN DONG: *see* Ban Pong  
BANG HUE HOM, Thailand: 17° 53' N., 100° 06' E.  
BANG HUE PONG: *see* Sathani Pang Hua Phong  
BANGKOK (160 miles north of), Thailand: 16° 00' N., 100° 45' E.  
BANGKOK: *see* Krung Thep  
BANGNARA: *see* Narathiwat  
BAN HAI HUAI SOM: *see* Ban Huai Som  
BAN HIN LAEM, Kanchanaburi, Thailand: 14° 40' N., 98° 40' E.  
BAN HIN NGOM, Nong Khai, Thailand: 17° 55' N., 102° 50' E.  
BAN HOI MAK: *see* Pak Hin Bun  
BAN HOUEI SAI, Laos: 20° 18' N., 100° 25' E.  
BAN HUAI SOM, Nan, Thailand: 18° 20' N., 100° 30' E.  
BAN HUANG SOM, Trat, Thailand: 11° 50' N., 102° 50' E.  
BANHUATHANON: *see* Ban Hua Thanon  
BAN HUA THANON, Kamphaeng Phet, Thailand: circa 16° 14' N., 99° 35' E.  
BAN HU KWANG, Nakon Sawan, Thailand: 15° 55' N., 100° 00' E.  
BAN HUP BON, Thailand: 13° 05' N., 101° 05' E.  
BAN KABIN BURI, Prachin Buri, Thailand: 14° 00' N., 101° 45' E.  
BANKACHON, Tenasserim, Burma: 10° 9' N., 98° 36' E.  
BAN KANG: *see* Ban Mae Klang  
BAN KHANA, Nan Province, Thailand: 19° 19' N., 100° 56' E.  
BAN KHLONG BANG LAI, Patiyu, Thailand: 10° 45' N., 99° 10' E.  
BAN KHLONG KHLUNG, Kamphaeng Phet, Thailand: 16° 10' N., 99° 45' E.  
BAN KHLONG MON, Samut Sakhon, Thailand: 13° 35' N., 100° 35' E.  
BAN KHLUA KLANG, Prachuap Khiri Khan, Thailand: circa 11° 35' N., 99° 39' E.  
BAN KHOK, Naphung, Dansai, Loei, Thailand: 16° 25' N., 101° 25' E.  
BAN KHOK KLAP: *see* Ban Na  
BAN KHUNG SAMPHAO, Thailand: 15° 20' N., 100° 00' E.  
BAN KIRIWONG: *see* Ban Wat Khiriwong  
BAN KLUA KLANG: *see* Ban Khlua Klang  
BAN KRAT, Thailand: 14° 26' N., 103° 04' E.  
BANLAD: *see* Ban Lat  
BAN LAEM NGOP, Trat, Thailand: 12° 08' N., 102° 35' E.  
BAN LAT, Phu Kheio, Chaiyaphum, Thailand: 16° 30' N., 101° 55' E.  
BAN LAT BUA KHAO, Nakhon Ratchasima, Thailand: 14° 50' N., 101° 35' E.  
BAN LE KATHE, Tak, Thailand: 15° 50' N., 98° 50' E.  
BAN LUANG, Chiang Mai, Thailand: 18° 25' N., 98° 40' E.  
BAN MAE KLANG, Thailand: 18° 30' N., 98° 40' E.  
BAN MAE MO, Thailand: 18° 15' N., 99° 45' E.  
BAN MAE SARIANG, Mae Hong Son, Thailand: 18° 10' N., 97° 55' E.  
BAN MAE TAN NUA, Lampeng, Thailand: 18° 20' N., 99° 25' E.  
BAN MAE TON: *see* Pang Mae Ton  
BAN MAHA CHAI, Samut Sakhon, Thailand: 13° 30' N., 100° 14' E.  
BAN MAKHAM TIA, Thailand: 9° 10' N., 99° 20' E.  
BAN MANAO WAN, Thailand: 14° 55' N., 101° 05' E.  
BAN MANASWAN: *see* Ban Manao Wan  
BAN MEH NA, Thailand: 19° 12' N., 98° 52' E.  
BAN ME THUOT: *see* Buon Ma Thuot  
BAN MI CHAI, Nongkhai, Thailand: 17° 50' N., 102° 50' E.  
BAN MUAK LEK, Sara Buri, Thailand: 14° 40' N., 101° 10' E.

- BAN MUANG KHAI, Tha Li, Muang Loei, Thailand: 17° 35' N., 101° 20' E.  
BAN MUNG KY: *see* Ban Muang Khai  
BAN NAI MUANG, Phichit, Thailand: 16° 25' N., 100° 20' E.  
BAN NA, Thailand: 8° 53' N., 99° 17' E.  
BAN NA KO, Nan, Thailand: circa 19° 10' N., 100° 54' E.  
BAN NAM CHUT YAI, Ranong, Thailand: 10° 25' N., 98° 45' E.  
"BAN NA MUANG, NA HAE0," *Dan Sai*, Loei, Thailand: 17° 15' N., 101° 02' E.  
BAN NAM YEN, Koksathon, Thailand: 17° 10' N., 101° 05' E.  
"BAN NA NONG," Chuempae [*Ban Chum Phae*], Khon Kaen, Thailand: 16° 34' N., 102° 03' E.  
BAN NENG KHO: *see* Ban Nong Kho  
BAN NONG BUA, Pasak River, Thailand: 14° 50' N., 101° 05' E.  
BAN NONG CHIK: *see* Ban Tuyong  
BAN NONG DON TA, Thailand: circa 18° 12' N., 104° 05' E.  
BAN NONG KHO, Chon Buri, Thailand: 13° 10' N., 101° 05' E.  
BAN NONG PLA LAI, Thailand: 16° 05' N., 98° 45' E.  
BAN NON TAO LEK, near Chaiyaphum, Thailand: 16° 27' N., 101° 50' E.  
BAN NON TOULEK: *see* Ban Non Tao Lek  
BAN PAK CHAN, Thailand: 10° 32' N., 98° 51' E.  
BAN PAK CHONG, Nakhon Ratchasima, Thailand: 14° 40' N., 101° 25' E.  
BAN PAKLI: *see* Ban Sopli  
BAN PAK NAM PHO, Nakhon Sawan, Thailand: 15° 40' N., 100° 10' E.  
BAN PAK THO, Rajburi, Thailand: 13° 21' N., 99° 50' E.  
BAN PHAN SADET, Thailand: 13° 05' N., 101° 05' E.  
BAN PHONE, Laos: 15° 25' N., 106° 35' E.  
BANPHOTPHISAI: *see* Ban Hu Kwang  
BAN PHU KHIEO, Chaiyaphum, Thailand: 16° 34' N., 101° 52' E.  
BAN PONG, Rat Buri, Thailand: 13° 50' N., 99° 55' E.  
BAN PUA, Nan, Thailand: 19° 11' N., 100° 53' E.  
BAN RAHAENG, Tak, Thailand: 16° 50' N., 99° 05' E.  
BAN SADET: *see* Ban Phan Sadet  
BAN SAHNG KAW: *see* Ban Sawan Ko  
BAN SAI KAN: *see* Nawngchik  
BAN SAI YOK, Kanchanaburi, Thailand: 14° 29' N., 98° 50' E.  
BAN SA KAE0, Prachin Buri, Thailand: 13° 50' N., 102° 05' E.  
BAN SALOK BAT, Kamphaeng Phet, Thailand: 16° 00' N., 99° 45' E.  
BAN SALUI: *see* Ban Khlong Bang Lai  
BAN SAN THA, Nan, Thailand: circa 18° 21' N., 100° 40' E.  
BAN SATTAHIP, Chon Buri, Thailand: 12° 40' N., 100° 55' E.  
BAN SAWAN KO, Sakon Nakhon, Thailand: 17° 27' N., 104° 05' E.  
BAN SICHON, Thailand: 9° 00' N., 99° 55' E.  
BAN SI KHIU, Nakhon Ratchasima, Thailand: 14° 55' N., 101° 45' E.  
BAN SI RACHA, Chon Buri, Thailand: 13° 10' N., 101° 05' E.  
BAN SOB PA [Soppa], Burma: 18° 48' N., 97° 27' E.  
BAN SOMPAN, Lower Burma: circa 10° 30' N., 98° 30' E.  
BAN SOPLI, Thailand: 18° 00' N., 100° 30' E.  
BAN TALOK BAT: *see* Ban Salok Bat  
BAN TARN DAM: *see* Ban Than Dam  
BAN TA YAI: *see* Ban Tha Yai  
BAN TAYUN, Plateau Bolovens, Laos: 15° 23' N., 106° 23' E.

- BAN THA CHANG, Thailand: 14° 35' N., 101° 25' E.  
 BAN THA KHANUM, Kanchanaburi, Thailand: 14° 45' N., 98° 40' E.  
 BAN THAN DAM: Near Ban Si Racha  
 BAN THANI, Sukhothai, Thailand: 17° 00' N., 99° 51' E.  
 BAN THA SAN, Ranong, Thailand: 10° 30' N., 98° 55' E.  
 BAN THATENG, Laos: 15° 25' N., 106° 23' E.  
 BAN THA YAI, Thailand: 8° 23' N., 99° 52' E.  
 BANTION: *see* Ban Tayun  
 BAN TON PHUNG, Laos: 20° 18' N., 100° 05' E.  
 BAN TUYONG, Thailand: 06° 50' N., 100° 00' E.  
 BAN UM PHANG: *see* Ban Le Kathe  
 BAN WANG MAI KHON, Sukhothai, Thailand: 17° 19' N., 99° 50' E.  
 BAN WANG TAKHIAN: *see* Kanchanaburi  
 BAN WAT KHIRIWONG, Thailand: circa 8° 23' N., 99° 52' E.  
 BAN WIANG TAI, Mae Hong Son, Thailand: 19° 20' N., 98° 25' E.  
 BAN WICHIAN, Thailand: 15° 40' N., 101° 05' E.  
 BAO HA, Tonkin, Viet Nam: 22° 10' N., 104° 23' E.  
 BARAPANI: *see* Borpani  
 BARIA, Cochín China, Viet Nam: 10° 30' N., 107° 10' E.  
 BAURANG, Yunnan [Sikang], China: 28° 52' N., 101° 23' E.  
 "BHADWAR," Kangra, Punjab: 32° 05' N., 76° 18' E.  
 BHOR PHLOY NONG YUNGCHANG: *see* King Bo Phloi  
 BHUKET: *see* Koh Phuket  
 BIEN HOA, Cochín China: 10° 52' N., 106° 50' E.  
 BINTENNA: *see* Pintenne  
 BOK PYIN, Tenasserim, Burma: 11° 15' N., 98° 46' E.  
 BORAPHET, Thailand: 15° 43' N., 100° 14' E.  
 BORI, Hoshangabad, India: 20° 55' N., 79° 05' E.  
 BORPANI, Khasi Hills, Assam, India: 25° 39' N., 91° 53' E.  
 BORPLOY: *see* King Bo Phloi  
 BOUN Tai: *see* Bun Tai  
 BOYCE'S POINT, Tenasserim, Burma: 10° 45' N., 98° 29' E.  
 BUKET: *see* Koh Phuket  
 BUNG BORAPET: *see* Boraphet  
 BUN TAI, Laos: 21° 18' N., 102° 00' E.  
 BUON MA THUOT, Viet Nam: 12° 40' N., 108° 05' E.  
 BURNIHAT, Assam, India: 25° 37' N., 91° 50' E.  
 CACHAR [Silchar], Assam, India: 24° 42' N., 92° 50' E.  
 CACHAR HILLS, Assam, India: 25° 00' N., 93° 00' E.  
 CHADUQUET POINT: *see* Laem Set Kuat  
 CHAIYAPHUM, Thailand: 16° 27' N., 101° 50' E.  
 CHAMAPHUM: *see* Ban Phu Kheio  
 CHAMPANG, Tenasserim, Burma: 10° 12' N., 98° 27' E.  
 CHAMRAJNAGAR, Mysore, India: 11° 55' N., 76° 55' E.  
 CHANCE ISLAND: *see* Ko Chan  
 CHANDRAGIRI PASS, Nepal: 27° 39' N., 85° 08' E.  
 CHANGWAT KAMPHAENG PHET, Kamphaeng Phet, Thailand: 16° 30' N., 99° 30' E.  
 CHANGWAT MAE HONG SON, Thailand: 19° 15' N., 97° 55' E.  
 CHANG YANG HSIEN, Hupeh, China: 30° 25' N., 111° 13' E.  
 CHANTABUN: *see* Chanthaburi



- CHANTHABURI, Thailand: 12° 35' N., 102° 05' E.  
CHAN TUK: *see* Ban Chan Thuk  
CHAO CHU, Yunnan, China: 25° 35' N., 100° 18' E.  
CHAPA: *see* Cha Pa  
CHA PA, Tonkin, Viet Nam: 22° 20' N., 103° 50' E.  
CHAUNG, 20 miles n.n.w. of Kindat, Burma: 23° 45' N., 94° 17' E.  
CHAUNG-LUNG, Salween ferry, Yunnan, China: 24° 12' N., 98° 58' E.  
CHENGA HKA, Burma: 26° 07' N., 95° 52' E.  
CHENGOU CREEK, 25 mi. W. of Wenchwan, Szechwan, China: 31° 20' N., 103° 00' E.  
CHENKANG, Yunnan, China: 24° 06' N., 99° 22' E.  
CHE PEI, Fu Min District: *see* Fuminhsien  
CHERRAPUNJI, Assam, India: 25° 13' N., 91° 47' E.  
CHETTIRI RANGE, Salem Dist., Madras, India: 11° 50' N., 78° 25' E.  
CHIANG, Szechwan, China: 28° 47' N., 102° 53' E.  
CHIANG RAI: *see* Muang Chiang Rai  
CHIANG SAEN KAO, Chiang Rai, Thailand: 20° 15' N., 100° 05' E.  
CHIANG SAEN LUANG: *see* Chiang Saen Kao  
CHEINAT: *see* Muang Chainat  
CHIENCHWAN: *see* Tienchüan  
CHIENG DAO: *see* Ban Chiang Dao  
CHIENGMAI: *see* Muang Chiang Mai  
CHIH PING: *see* Shihpingchow  
"CHI LI PING," *Fanghsien*, Hupeh, China: 32° 03' N., 110° 54' E.  
CHIMELI PASS, Upper Burma: 26° 08' N., 98° 40' E.  
CHINBYIT, Burma: 22° 03' N., 94° 40' E.  
CHING-CHIEN-SHIEN: *see* Tsingkien  
CHING FENG LING, Fukien, China: 27° 11' N., 118° 13' E.  
CHINTEH: *see* Tsingteh  
CHINWANGTAO, Hopeh, China: 39° 56' N., 119° 37' E.  
CHIN WANG TAS: *see* Chinwangtao  
CHIP-CHIP, Formosa: circa 23° 55' N., 120° 45' E.  
CHIPWI, northeastern Burma: 25° 52' N., 98° 07' E.  
CHOMTONG: *see* Ban Luang  
CHORA, Tonkin, Viet Nam: 22° 18' N., 105° 52' E.  
CHULUNGAPU, Upper Tebbuland, Kansu, China: circa 34° N., 101° 30' E.  
CHUMPHON, Thailand: 10° 30' N., 99° 10' E.  
CHUM POO: *see* Sathani Tha Chomphu  
CHUNGANHSIEN, Fukien, China: 28° 02' N., 117° 53' E.  
CHUNGAN HSIEN: *see* Chunganhsien  
CHUNG CHIAO MIAO: *see* Chiang  
CHUNG KING, Szechwan, China: 29° 34' N., 106° 35' E.  
CHUNGTANG, Sikkim, India: 27° 37' N., 88° 38' E.  
CHUNTOWN: *see* Chumphon  
CLARA ISLAND, Mergui Archipelago, Burma: 10° 50' N., 97° 55' E.  
COIMBATORE, Madras, India: 10° 55' N., 76° 58' E.  
COL DES NUAGES, Annam, Viet Nam: 16° 11' N., 108° 10' E.  
COL DE TALOUN, Laos: 19° 50' N., 102° 15' E.  
COORG, India: 12° 00' N., 76° 00' E.  
"COTENGADY ESTATE," [Nelliampathi Hills, *Palghat* District], Cochin, India:  
10° 40' N., 76° 35' E.

CUCHAI: *see* Kuchai

DA BAN, Phanrang Province, Annam: 12° 38' N., 109° 06' E.

DACCA, East Pakistan: 23° 43' N., 90° 26' E.

DAGUNG HKA, Burma: 26° 05' N., 95° 55' E.

DAK-TO, Annam, Viet Nam: 14° 40' N., 107° 45' E.

DAINGMHU, 40 mi. N. of Pegu, Burma: 17° 42' N., 96° 14' E.

DALAT, Annam, Viet Nam: 11° 58' N., 108° 25' E.

DALU, N. Burma: 26° 20' N., 96° 12' E.

DAO SOI DAO: *see* Khao Soi Dao

DARJEELING, Bengal, India: 27° 00' N., 88° 18' E.

DARUGIRI, Garo Hills, Assam, India: 25° 37' N., 90° 46' E.

DELISLE, Thailand: 09° 40' N., 98° 20' E.

DEN CHAI, near Bang Hue Hom, Thailand: circa 17° 53' N., 100° 06' E.

DENING, Mishmi Hills, Assam, India: 28° 01' N., 96° 10' E.

DEVIKOP, S. Mahratta, India: 15° 08' N., 75° 00' E.

DIKCHU, Sikkim, India: 27° 25' N., 88° 35' E.

DJIRING, Annam, Viet Nam: 11° 35' N., 108° 06' E.

DOI ANGKA: *see* Doi Inthanon

DOI CHIANG DAO: *see* Doi Luang Chiang Dao

DOI CHIENGDAO: *see* Doi Luang Chiang Dao

DOI HUA MOT: *see* Chiangmai

DOI INTHANON, Chiang Mai, Thailand: 18° 32' N., 98° 32' E.

DOI KANG MA: *see* Doi Khang Ma

DOI KHANG MA, Chiang Mai, Thailand: circa 18° 08' N., 98° 27' E.

DOI KHUN TAN, Lamphun, Thailand: 18° 30' N., 99° 20' E.

DOI LAK SAEN, Thailand: circa 18° 08' N., 98° 07' E.

DOI LAK SEN: *see* Doi Lak Saen

DOI LANGKA: *see* Khao Pha Cho

DOI LUANG CHIANG DAO, Chiang Mai, Thailand: 19° 25' N., 98° 55' E.

DOI MAE KONG KA, Mae Hong Son, Thailand: circa 18° 06' N., 97° 49' E.

DOI ME KONG KHA: *see* Doi Mae Kong Ka

DOI MAE LAI, Mae Hong Son, Thailand: circa 18° 09' N., 98° 00' E.

DOI MEI LAI: *see* Doi Mae Lai

DOI NANGKA: *see* Khao Pha Cho

DOI NANG KEO: *see* Doi Phi Phan Nam

DOI PAR SAKENG, northwestern Thailand: 19° 35' N., 99° 03' E.

DOI PHI PHAN NAM, Chiang Mai, Thailand: 19° 05' N., 99° 25' E.

DOI PHRA CHAO: *see* Khao Pha Cho

DOI PHU HET, Nan, Thailand: circa 18° 20' N., 100° 35' E.

DOI PHU KA, Nan, Thailand: 19° 05' N., 101° 05' E.

DOI PHU KHA, Thailand: 19° 05' N., 101° 05' E.

DOI PU HET: *see* Doi Phu Het

DOI PU KHA: *see* Doi Phu Kha

DOI SAN HUAI WAI, Nan, Thailand: circa 18° 20' N., 100° 35' E.

DOI SRITEPE: *see* Doi Suthep

DOI SUTEP: *see* Doi Suthep

DOI SUTHEP, Chiang Mai, Thailand: 18° 50' N., 98° 55' E.

DOMEL ISLAND, Mergui, Burma: 11° 37' N., 98° 15' E.

DONGHAI: *see* Dong Hoi

DONG HOI, Annam, Viet Nam: 17° 32' N., 106° 35' E.

- DON QUA, Laos: 19° 45' N., 102° 35' E.
- DOONSA, near junction Gyn [Gyaing] and Haung Thrau [Haung Tharaw] Rivers, near Moulmein, Burma: 16° 37' N., 98° 00' E.
- DRACHUAPCHIRI KHAN BANKHLUAKLANG: *see* Ban Khlua Klang
- DREYI, Mishmi Hills, Tibet: 28° 03' N., 96° 15' E.
- DURAGIRI: *see* Darugiri
- "EAKTUR," E. of Ban Me Thuot: *see* Buon Ma Thuot
- EASTERN TOMBS, Hopeh, China: 40° 00' N., 117° 00' E.
- ETAWAH United Provinces, India: 26° 50' N., 79° 00' E.
- FANGHSIEN, Hupeh, China: 32° 03' N., 110° 54' E.
- FANSIPAN: *see* Mt. Fan-si-pan
- FENGSIANGFU, Shensi, China: 34° 24' N., 107° 29' E.
- FENG YANG, Yunnan, China: 24° 45' N., 102° 40' E.
- FIMNON, S. Annam, Viet Nam: 11° 40' N., 108° 22' E.
- FI SHAN KWAN, Szechwan, China: 30° 03' N., 103° 05' E.
- FOOCHOW, Fukien, China: 26° 05' N., 119° 18' E.
- FUCHING: *see* Futsing
- FUCHOW, Fukien, China: 26° 05' N., 119° 18' E.
- FU FU SU, Szechwan, China: 29° 35' N., 103° 35' E.
- FU LIN, Szechwan, China: 29° 20' N., 102° 45' E.
- FUMINHSIEN, Yunnan, China: 25° 12' N., 102° 31' E.
- FUTSING, Fukien, China: 25° 40' N., 119° 25' E.
- GAMMADUWA, Ceylon: 07° 35' N., 80° 41' E.
- GANGFANG, Burma: 26° 06' N., 98° 38' E.
- GANGTOK, Sikkim, India: 27° 20' N., 88° 30' E.
- GHATMATHA, Satara District, Bombay, India: 17° 25' N., 73° 40' E.
- GOALPARA, Assam, India: 26° 10' N., 90° 37' E.
- GODAVARI, Nepal: 27° 35' N., 85° 20' E.
- GODAVERI: *see* Godavari
- GOKTEIK, Northern Shan States, Burma: 22° 20' N., 96° 52' E.
- GOLAGHAT, Assam, India: 26° 30' N., 94° 01' E.
- GOPALDHARA, Rungbong Valley, India: 26° 55' N., 88° 12' E.
- GORKHA, Nepal: *see* Satthar
- GOUGH: *see* Lien Gongah
- GUNGWADORIA, north slope of Palni Hills, India: circa 10° 20' N., 77° 30' E.
- GYAING, and HAUNG THRAU [Haung Tharaw] RIVERS, near Moulmein, Burma: 16° 37' N., 98° 00' E.
- HA-GANG: *see* Ha Giang
- HA GIANG, Tonkin, Viet Nam: 22° 50' N., 104° 58' E.
- HAHTI, Burma: 26° 04' N., 95° 32' E.
- HAI BUM, Burma: 26° 02' N., 95° 47' E.
- HAI YEN HSIEN, Hangchow Bay, Chekiang: 30° 17' N., 120° 10' E.
- HAMBANTOTA, Ceylon: 06° 07' N., 81° 07' E.
- HASTINGS ISLAND, Mergui Archipelago, Burma: 10° 05' N., 98° 20' E.
- HATHIBAN, Nepal: 27° 37' N., 85° 15' E.
- HATHIBEN: *see* Hathiban
- HATAURA, Nepal: 27° 25' N., 85° 05' E.
- HAT SANUK, Rajburi, Thailand: 11° 52' N., 99° 42' E.
- HAUNGTHARAW RIVER (where crossed by Moulmein-Kawkareik road), Burma: 16° 30' N., 98° 05' E.

- HEINSUM, Burma: 25° 52' N., 95° 32' E.  
 HELWAK, Satara Dist., Bombay, India: 17° 20' N., 73° 40' E.  
 HETORA: *see* Hataura  
 HINLAEM: *see* Ban Hin Laem  
 HIN LAP: *see* Sathani Hin Lap  
 HKAMKAWN, Burma: 26° 02' N., 98° 23' E.  
 HKAMTI, Burma: 26° 00' N., 95° 42' E.  
 HKAMTI Plain, Burma (taken to be the same locality as Putao and Ft. Hertz):  
 27° 22' N., 97° 27' E.  
 HKAWNI, Gaw, Upper Burma: 25° 58' N., 98° 00' E.  
 HMAWBI, 40 km. north of Rangoon, Burma: 17° 05' N., 96° 05' E.  
 HNATHIAL, Lushai Hills, Assam, India: circa 23° 45' N., 92° 55' E.  
 HOI XUAN, Annam, Viet Nam: 20° 20' N., 105° 05' E.  
 HOKOW, Szechwan, China: 30° 01' N., 101° 08' E.  
 HOMALIN, Burma: 24° 53' N., 94° 55' E.  
 HOMU-SHU PASS, Yunnan, China: 24° 55' N., 98° 45' E.  
 HOOPBON: *see* Ban Hup Bon  
 HOSHANGABAD, India: 22° 45' N., 77° 45' E.  
 HOUE SAI: *see* Ban Houei Sai  
 HPIMAW, Salween-Irrawaddy Divide, Burma: 25° 58' N., 98° 38' E.  
 HSIAO-MENG-TUNG: *see* Siaomengtung  
 HSIAO YANG CHI, Szechwan, China: 28° 47' N., 102° 44' E.  
 HSIEN SHAN HSIEN, Hupeh, China: 31° 30' N., 110° 55' E.  
 HSING LIAO PA, Kweichow, China: 28° 14' N., 106° 33' E.  
 HSIN KAI: *see* Sinkai  
 HSIN LUNG SHAN, Jehol, Manchuria: 40° 38' N., 117° 17' E.  
 HSIPAW, Shan States, Burma: 22° 38' N., 97° 20' E.  
 HTAWGAW, Burma: 25° 55' N., 98° 25' E.  
 HTINGWAN, Burma: 26° 31' N., 97° 52' E.  
 HUAI NUA PLA, Tak, Thailand: 16° 54' N., 98° 48' E.  
 HUE SAI, near Koh Lak, Thailand: circa 11° 48' N., 99° 47' E.  
 HUE YAH PLA: *see* Huai Nua Pla  
 HUEY YANG: *see* Ban Si Racha  
 HULAUNG, Burma: 25° 10' N., 95° 05' E.  
 HUNGAI, 40 miles E. of Talifu, Yunnan, China: circa 25° 30' N., 100° 20' E.  
 HUNG FA CHAO: *see* Shanghai  
 HUP BON: *see* Ban Hup Bon  
 HUP BUM: *see* Ban Hup Bon  
 HWANG TSAO PA: *see* Hwangtsaopa  
 HWANGTSAOPA, Kweichow, China: 24° 57' N., 104° 36' E.  
 ICHANG, Hupeh: 30° 45' N., 111° 22' E.  
 ICHANG HSIEN, Hupeh, China: 30° 42' N., 111° 17' E.  
 I-LAN HSIEN, I-Lan, Taipei, Taiwan, China: 24° 25' N., 121° 42' E.  
 IMAW BUM: *see* Mt. Imaw Bum  
 INTA, Burma: 24° 30' N., 94° 42' E.  
 IPIN, Szechwan-Yunnan border, China: 28° 43' N., 104° 32' E.  
 ISLE [Ile] DE LA TABLE, Tonkin, Viet Nam: 20° 57' N., 107° 30' E.  
 JAMES ISLAND, Mergui Archipelago, Burma: 10° 25' N., 98° 17' E.  
 JHIMPIR LAKE, Sind, India: 25° 00' N., 68° 00' E.  
 KABAW VALLEY, 20 mi. W. of Kindat, Burma: 23° 40' N., 94° 12' E.



- KACHEK, Hainan, China: 19° 14' N., 110° 27' E.  
 KADRANGYANG, Fort Hertz Rd., 75 mi. N. of Myitkyina, Burma: circa 26° 07' N., 97° 30' E.  
 KAGI DIST., Formosa: 23° 29' N., 120° 17' E.  
 KAING R., S. Pyinwana, S. Burma: 19° 44' N., 96° 09' E.  
 KALEWA, Burma: 23° 12' N., 94° 13' E.  
 KALHATTI [Falls], Nilgiri Hills, India: 11° 27' N., 76° 43' E.  
 KALUTARA, Matugama, Ceylon: 06° 34' N., 79° 58' E.  
 KAMPENG PET: *see* Kamphaeng Phet  
 KAMPHAENG PHET, Thailand: 16° 30' N., 99° 30' E.  
 KAMPOT, Cambodia: 10° 40' N., 104° 18' E.  
 KAN BOURI: *see* Kanchanaburi  
 KANCHANABURI, Thailand: 14° 00' N., 99° 30' E.  
 KANGPU: *see* Kanpu  
 KANGRA, Punjab: 32° 05' N., 76° 18' E.  
 KANJANABURI: *see* Kanchanaburi  
 KANPU, near Hangchow, Chekiang, China: 30° 20' N., 120° 50' E.  
 KAO CHIAO, Yunnan, China: 25° 01' N., 102° 20' E.  
 KAO HAO, Quangtri Province, Annam, Viet Nam: 16° 45' N., 107° 11' E.  
 KAO LEM: *see* Khao Laem  
 KAO LUANG, Huey Yang: *see* Khao Luang, Sathani Huai Yang (not the same locality as Khao Luang, Nakhon Si Thammarat)  
 KAO SABAB: *see* Khao Sa Bap  
 KAO SEMING: *see* Khao Saming  
 KAOSHANSHIH, near Foochow, Fukien, China: 25° 25' N., 119° 28' E.  
 KAO SOI DAO: *see* Khao Soi Dao  
 KAOTIEN, Fukien, China: 27° 18' N., 117° 25' E.  
 KAO TUNG SAWNG: *see* Khao Thung Song  
 KARJINE: *see* Ban Pak Tho  
 KARONG, Manipur, Assam, India: 25° 15' N., 94° 05' E.  
 KATHA, Burma: 24° 10' N., 96° 20' E.  
 KAUKTAUNG, Burma: 25° 43' N., 95° 25' E.  
 KAUNGHEIN, Burma: 25° 42' N., 95° 24' E.  
 KAWAI, Burma: 26° 02' N., 95° 34' E.  
 KAWKAREIK, Burma: 16° 28' N., 98° 16' E.  
 KAWLAW, Southern Shan States, Burma: 20° 38' N., 96° 34' E.  
 KAWLICHANG, Burma: circa 16° 15' N., 98° 25' E.  
 KAW NOM PLU: *see* Khao Nam Pliu  
 KELLENGODE: *see* Kollangod  
 KEMPANPET: *see* Changwat Kamphaeng Phet  
 KHAD THAM PHRA, Laos: 20° 15' N., 100° 05' E.  
 KHAJJEAN: *see* Kangra  
 KHA NU, Kampeng Phet, Thailand: 16° 07' N., 99° 46' E.  
 KHAO ERAWAN, Lop Buri, Thailand: circa 14° 50' N., 100° 35' E.  
 KHAO KHAT, Nakhon Sawan, Thailand: 15° 43' N., 100° 07' E.  
 KHAO KOP, Nakhon Sawan, Thailand: 15° 43' N., 100° 08' E.  
 KHAO LAEM, Thailand: 14° 25' N., 101° 30' E.  
 KHAO LUANG, Sathani Huai Yang, Thailand: 11° 36' N., 99° 41' E. (not the same locality as Khao Luang, Nakhon Si Thammarat)  
 KHAO NA KHAE: *see* Khao Thung Song

- KHAO NAM PLIU, Thailand: 7° 35' N., 99° 50' E.  
 KHAO PHA CHO, Chiang Mai, Thailand: 19° 00' N., 99° 25' E.  
 KHAO PHRA PHUT, Lop Buri, Thailand: 14° 50' N., 100° 40' E.  
 KHAO SA BAP, Chanthaburi, Thailand: 12° 35' N., 102° 15' E.  
 KHAO SAMING, Trat, Thailand: 12° 21' N., 102° 27' E.  
 KHAO SOI DAO, S.E. Thailand: 15° 30' N., 100° 45' E. (not the same locality as  
     Khao Soi Dao, Trong, Thailand)  
 KHAO THUNG SONG, Peninsular Thailand: 8° 20' N., 99° 48' E.  
 KHARAGPUR, Bengal, India: 22° 20' N., 87° 20' E.  
 KHET DONG HEING, Laos: 17° 53' N., 101° 34' E.  
 KHLONG WANG HIP, Thailand: circa 8° 12' N., 99° 43' E.  
 KHON KAEN, Thailand: 16° 25' N., 102° 40' E.  
 KHUN TAN MTS.: *see* Doi Khun Tan  
 KIATING: *see* Loshan  
 KIENYANG, Fukien, China: 27° 21' N., 118° 05' E.  
 KIL: *see* Kotajiri  
 KIN, Burma: 22° 41' N., 94° 41' E.  
 KINDAT, Burma: 23° 40' N., 94° 22' E.  
 KING BO PHLOI, Kanchanaburi, Thailand: 14° 48' N., 99° 10' E.  
 KING CHIANG SAEN: *see* Chiang Saen Kao  
 KING ISLAND, Mergui Archipelago, Burma: 12° 30' N., 98° 22' E.  
 KISSERIAN ISLAND, Burma: 11° 41' N., 98° 28' E.  
 KLONG BAN LAI: *see* Ban Khlong Bang Lai  
 KLONG KLUNG: *see* Ban Khlong Khlung  
 KLONG MENAO: *see* Ban Huang Som  
 KLONG MORN: *see* Ban Khlong Mon  
 KLONG WANG HIP: *see* Khlong Wang Hip  
 KLONG YAI, Thailand: 11° 44' N., 102° 52' E.  
 KO CHAN, Mergui Archipelago, Thailand: 9° 25' N., 97° 50' E.  
 KO CHANG, Trat, Thailand: 12° 00' N., 102° 30' E.  
 KODAIKANAL, India: 10° 12' N., 77° 30' E.  
 KODURA, Balapalli Range, Madras, India: 13° 57' N., 79° 32' E.  
 KOH CHANG ISLAND: *see* Ko Chang  
 KO-CHIA-HO-PA, Szechwan, China: circa 30° 20' N., 102° 20' E.  
 KOHIMA, Assam, India: 25° 40' N., 94° 12' E.  
 KOH KUT ISLAND: *see* Ko Kut  
 KOH LAK: *see* Prachuap Khiri Khan  
 KOH LAN: *see* Ko Lan  
 KOH PANGAN: *see* Ko PHANGAN  
 KOH PHAI: *see* Ko Phai  
 KOH PHUKET, Southwestern Thailand: 7° 53' N., 98° 24' E.  
 KOH SI CHANG: *see* Ko Si Chang  
 KOH TAO: *see* Ko Tao  
 KOKKOAING, Burma: 22° 28' N., 96° 18' E.  
 KOKKOGON: *see* Kokkogwa  
 KOKKOGWA, Burma: 19° 59' N., 95° 30' E.  
 KO KUT, TRAT, Thailand: 11° 40' N., 102° 35' E.  
 KO LAK: *see* Prachuap Khiri Khan  
 KO LAN, Chon Buri, Thailand: 12° 55' N., 100° 45' E.  
 KOLLANGOD, India: 10° 38' N., 76° 37' E.

- KOLLEGAL, Coimbatore, India: 12° 10' N., 77° 10' E.  
KO MAPHRAO, Thailand: 7° 55' N., 98° 25' E.  
KONTUM: *see* Kontum  
KONTUM, Annam, Viet Nam: 14° 25' N., 107° 55' E.  
KOON TAN: *see* Doi Kuhn Tan  
KO PHAI, Chonburi, Thailand: 12° 55' N., 100° 40' E.  
KO PHANGAN, Thailand: 09° 45' N., 100° 00' E.  
KO SI CHANG, Chon Buri, Thailand: 13° 10' N., 100° 50' E.  
KOTAJIRI, Nilgiri Hills, India: 11° 25' N., 76° 55' E.  
KO TAO, Surat Thani, Thailand: 10° 05' N., 99° 50' E.  
KOTAWA, Ceylon: 06° 03' N., 80° 20' E.  
KOWJEEN: *see* Ban Pak Tho  
KOWKAT: *see* Khao Khat  
KOWKOB: *see* Khao Kop  
KRABIN: *see* Ban Kabin Buri  
KRAT: *see* Ban Krat  
KRATT: *see* Ban Krat  
KRONG BA, S. Annam, Viet Nam: 14° 00' N., 108° 18' E.  
KRUNG THEP, Phra Nakhon, Thailand: 13° 45' N., 100° 30' E.  
KUCHAI, Yunnan, China: 27° 20' N., 103° 14' E.  
KUCHENG, Fukien, China: 26° 40' N., 118° 43' E.  
KU-LU, Szechwan, China: 28° 05' N., 101° 12' E.  
KUMBUKKAN, Uva Prov., Ceylon: 06° 47' N., 81° 17' E.  
KUNMING: *see* Yunnanfu  
KURUMBAPATTI, India: 11° 45' N., 78° 15' E.  
KUSHAN: *see* Kaoshanshih  
KUTUNG, Yunnan, China: 25° 27' N., 99° 30' E.  
KWATUM: *see* Kaotien  
KWE KOI: *see* Mae Nam Khwae Noi  
KYAUKMYAUNG, Burma: 22° 30' N., 95° 57' E.  
KYUNDAW, Burma: 21° 10' N., 94° 40' E.  
LACHEN, Sikkim, India: 27° 45' N., 88° 32' E.  
LACHUNG, Sikkim, India: 27° 43' N., 88° 44' E.  
LACON SRITAMARAT: *see* Nakhon Si Thammarat  
LAEM SET KUAT, Thailand: 10° 05' N., 98° 40' E.  
LAEM SING, Chantaburi, Thailand: 12° 30' N., 102° 05' E.  
LAHKAW HKA, Burma: 26° 25' N., 96° 12' E.  
LAHORE, Punjab: 31° 35' N., 74° 15' E.  
LAI CHAU, Tonkin, Viet Nam: 21° 52' N., 103° 10' E.  
LAITLYNKOT, Khasi Hills, Assam, India: 25° 27' N., 91° 51' E.  
LAI YOKE: *see* Ban Sai Yok  
LAKCHANG GA, Burma: 26° 16' N., 96° 07' E.  
LAKHON: *see* Muang Lampang  
LAKYA, Tenasserim, Burma: circa 16° 15' N., 98° 25' E.  
LAMAYA, Szechwan, China: 29° 52' N., 99° 54' E.  
LAMPHA, Burma: 16° 18' N., 98° 19' E.  
LAM-RA: *see* Sathani Lamphura  
LANDA [Londa], India: 14° 30' N., 74° 25' E.  
LANGBIAN PEAKS, Annam, Viet Nam: 12° to 12° 15' N., 108° 20' E.  
LANG SON, Tonkin, Viet Nam: 21° 50' N., 106° 45' E.

- LANGYANG, Burma: 25° 54' N., 98° 18' E.  
 LAO BAO, Laos: 16° 37' N., 106° 34' E.  
 LAO FOU TCHAY, Laos: 21° 43' N., 102° 25' E.  
 LAO KAY, Tonkin, Viet Nam: 22° 30' N., 104° 00' E.  
 LAT BUA KAO: *see* Ban Lat Bua Khao  
 LAUKHAUNG, Burma: 25° 53' N., 98° 13' E.  
 LAWKSAWK, Burma: 21° 13' N., 96° 50' E.  
 LAY SONG HONG: *see* Thale Song Hong  
 LE BOKOR, Cambodia: 10° 40' N., 104° 00' E.  
 LEI-MUI-MON, Hainan, China: 19° 00' N., 109° 30' E.  
 LEM NGOP: *see* Ban Laem Ngop  
 LEM SING MOUNTAIN: *see* Laem Sing  
 LENG SANG, Tonkin, Viet Nam: 22° 25' N., 103° 17' E.  
 LIAN-FENG-KIANG, Omei Shan, Szechwan, China: 29° 25' N., 103° 25' E.  
 LICHANG: *see* Likiang  
 LIEN GONGAH, Annam, Viet Nam: 11° 30' N., 108° 20' E.  
 LIENG SAN: *see* Leng Sang  
 LIKIANG, Yunnan, China: 27° 04' N., 100° 12' E.  
 LIMPA, Burma: 25° 45' N., 95° 30' E.  
 LINGTAM: *see* Singtam  
 LITIEN, Yunnan, China: 27° 14' N., 99° 27' E.  
 LIU-TSUEN, Shensi, China: 34° 02' N., 108° 55' E.  
 LO-GUI-HO, Tonkin, Viet Nam: 22° 19' N., 103° 42' E.  
 LOMLOE MT., Ban Maeo, Goksatawn, Dahnsai, Loey, Thailand: 17° 00' N.,  
 101° 00' E.  
 LONG LUNG: *see* Ban Nong Pla Lai  
 LONKIN, Burma: 25° 40' N., 96° 22' E.  
 LONPAN: *see* Sungpan  
 LOSHAN, Szechwan, China: 29° 35' N., 103° 40' E.  
 LO TIAO, Laos: 20° 20' N., 100° 05' E.  
 LO TU KOW: *see* Lukou  
 LSIEN: *see* Wutingchow  
 LUANG PRABANG, Laos: 19° 53' N., 102° 10' E.  
 LU CHANG PU, Szechwan, China: 29° 23' N., 108° 10' E.  
 LUIA, Chaibassa, India: 22° 35' N., 85° 25' E.  
 LUKOU, Yunnan, China: 25° 55' N., 98° 50' E.  
 LUNGCHOW, Kwangsi, China: 22° 22' N., 106° 54' E.  
 LUNGHKANG (Ga), Burma: 26° 36' N., 97° 48' E.  
 LUNGKAI, Yunnan, China: 25° 57' N., 101° 54' E.  
 LUNGTAN, China: 32° 05' N., 119° 20' E.  
 LUNG VAN: *see* Van Lung  
 LUTINGKIAO, China: 29° 54' N., 102° 28' E.  
 LUTING SHAN: *see* Lutingkiao  
 MA-CHANG-KAI, Tengyueh, Yunnan, China: 24° 39' N., 98° 00' E.  
 MADAYA FOREST, Burma: 22° 30' N., 96° 06' E.  
 MADISCHUNG VALLEY, Sikang, China: 26° 12' N., 101° 59' E.  
 MAE HONG SONG: *see* Changwat Mae Hong Son  
 MAE KLONG, Thailand: 13° 26' N., 100° 01' E.  
 MAE NAM KHWAEE NOI, Kanchanaburi, Thailand: 14° 00' N., 99° 30' E.  
 MAE NAM YOM, Prae, Thailand: 15° 52' N., 100° 16' E.



- MAE PAN, Phrae, Thailand: 18° 00' N., 100° 00' E.  
MAE TAW FOREST, Thailand: 17° 20' N., 99° 35' E.  
MAE THA KHWAEE, Tak, Thailand: 16° 54' N., 98° 52' E.  
MAE WAN RIVER near Doi Saket, Thailand: 18° 50' E., 99° 35' E.  
MA FU LING, Hupeh, China: 31° 52' N., 110° 18' E.  
MAHA OYA, Ceylon: 07° 30' N., 81° 19' E.  
MA KAI HSIEN: *see* Makai  
MAKAI, Yunnan, China: 25° 42' N., 101° 55' E.  
MALIPA, Burma: 23° 40' N., 98° 45' E.  
MALIWUN, Burma: 10° 12' N., 98° 40' E.  
MAMOH: *see* Pakchan  
MANDALAY, Burma: 21° 59' N., 96° 08' E.  
MANGPU, Bengal, India: 26° 58' N., 88° 27' E.  
M. ANGTON: *see* Muang Phrom Buri  
MANKENI, Ceylon: 08° 00' N., 81° 30' E.  
MANORAM: *see* Ban Khung Samphao  
MANSUM, Burma: 25° 47' N., 96° 15' E.  
MANTHE, Burma: 25° 18' N., 95° 13' E.  
MAPRAU ISLAND: *see* Ko Maphrao  
MARGHERITA, Assam, India: 27° 17' N., 95° 47' E.  
MARTABAN, Burma: 16° 30' N., 97° 28' E.  
MATANGA RIVER, N. Kamrup, Assam: circa 26° 30' N., 91° 30' E.  
MATINGA: *see* Matanga River  
MATSATAP, Burma: 27° 30' N., 97° 50' E.  
MATUGAMA, Ceylon: 06° 30' N., 80° 08' E.  
MAUNGKAN, Burma: 25° 05' N., 95° 00' E.  
MAWLAIK, Burma: 23° 38' N., 94° 22' E.  
MAWLYNGKUENG, Assam, India: 25° 34' N., 92° 03' E.  
MAWPHLANG, Assam, India: 25° 27' N., 91° 46' E.  
MAWRYNGKUENG: *see* Mawlyngkueng  
MAYMYO, Burma: 22° 05' N., 96° 30' E.  
M. CHUM PON: *see* Ban Tha San  
MEE NAN, 30 miles N.E. of Uttaradit, Thailand: 17° 50' N., 100° 15' E.  
MEE PAN: *see* Mae Pan  
MEE TAN: *see* Ban Mae Tan Nua  
MEHONGSON: *see* Changwat Mae Hong Son  
MEIKTILA, Burma: 20° 50' N., 95° 52' E.  
MEKONG-SALWIN [Salween] DIVIDE, Sikang, China: 28° 20' N., 99° 20' E.  
MEKONG VALLEY, Yunnan, China: 28° 00' N., 99° 23' E.  
MEKONG-YANGTZE DIVIDE, Yunnan, China: 27° 30' N., 99° 25' E.  
MELAMOUNG: *see* Me Lamung  
ME LAMUNG, Thailand: 15° 32' N., 98° 48' E.  
ME MOH: *see* Ban Mae Mo  
MENG-TING, Yunnan, China: 23° 31' N., 99° 06' E.  
ME PING RIVER [Mae Ping], 180 miles N. of Bangkok, Thailand: circa 16° 40' N., 99° 55' E.  
MESARIENG: *see* Ban Mae Sariang  
ME TAQUA: *see* Mae Tha Khwae  
ME TAW FOREST: *see* Mae Taw Forest  
ME WONG RIVER, 53 mi. E. of Um Pang, Thailand: 15° 50' N., 99° 38' E.

- ME YAM RIVER: *see* Mae Nam Yom
- MILI, Szechwan, China: 28° 11' N., 100° 50' E.
- MINGUN, Sagaing, Burma: 22° 00' N., 95° 57' E.
- MISHMI HILLS, Assam, India: circa 28° 00' N., 96° 10' E.
- M. MOUEN: *see* Moung Mouen
- MOKANSHAN, Chekiang, China: 30° 26' N., 119° 47' E.
- MOKLOK, Burma: 25° 37' N., 95° 25' E.
- MOKOKCHUNG, Assam, India: 26° 24' N., 94° 32' E.
- MONG CHIT: *see* Ban Tuyong
- MONG HA, N. Shan States, Burma: 22° 20' N., 98° 15' E.
- MONGKHOR: *see* Ban Nong Kho
- MONGTZE, Yunnan, China: 25° 56' N., 112° 14' E.
- MOUNG BOUM, Tonkin, Viet Nam: 22° 32' N., 102° 50' E.
- MOUNG MO, Tonkin, Viet Nam: 22° 12' N., 102° 56' E.
- MOUNG MOUEN, Tonkin, Viet Nam: 21° 30' N., 103° 00' E.
- MOUNG MOUN, Tonkin, Viet Nam: 21° 36' N., 103° 20' E.
- MOUNG YO, Laos: 21° 28' N., 101° 52' E.
- MT. ANGKA: *see* Doi Inthanon
- MT. ARIZAN, Formosa: 23° 32' N., 120° 46' E.
- MT. AVA, Burma: 21° 52' N., 96° 01' E.
- MT. FAN-SI-PAN, Tonkin, Viet Nam: 22° 19' N., 103° 49' E.
- MT. IMAW BUM, Burma: 26° 08' N., 98° 30' E.
- MT. MOOLEYIT: *see* Mulai-yit Hill
- MT. NVALABO, Burma: 14° 07' N., 98° 28' E.
- MT. OMEI, Szechwan, China: 29° 25' N., 103° 25' E.
- MT. POPA, Burma: 20° 58' N., 95° 20' E.
- MT. TURA, Assam, India: 25° 27' N., 90° 30' E.
- MT. VICTORIA, Burma: 21° 17' N., 93° 53' E.
- MT. WUCHI: *see* Wuchi Shan
- MOUPINE: *see* Muping
- MUAKLEK [Muak Lek], Sraburi [Sara Buri], Thailand: 14° 35' N., 101° 17' E.
- MUANG CHAINAT, Thailand: 15° 10' N., 100° 10' E.
- MUANG CHIANG MAI, Thailand: 18° 45' N., 99° 00' E.
- MUANG CHIANG RAI, Thailand: 19° 55' N., 99° 50' E.
- MUANG LAMPANG, Thailand: 18° 18' N., 99° 31' E.
- MUANG NAN, Thailand: 18° 47' N., 100° 47' E.
- MUANG NONG KHAI, Thailand: 17° 52' N., 102° 44' E.
- MUANG PAI: *see* Ban Wiang Tai
- MUANG PHICHIT: *see* Ban Nai Muang
- MUANG PHITSANULOK, Thailand: 16° 50' N., 100° 15' E.
- MUANG PHROM BURI, Anghtong or Sing Buri, Thailand: 14° 50' N., 100° 26' E.
- MUANG PROM: *see* Muang Phrom Buri
- MUANG QUA YIE: *see* Nakhon Sawan
- MU CHENG, Yunnan, China: 23° 45' N., 99° 10' E.
- MUDUMALAI, India: 11° 37' N., 76° 31' E.
- MUEK LEK: *see* Ban Muak Lek
- MULAI-YIT HILL, Burma-Thailand border: 16° 05' N., 98° 43' E.
- MUNSIN, Burma: 25° 33' N., 95° 20' E.
- MUONG BOUM, Tonkin, Viet Nam: 22° 32' N., 102° 50' E.
- MUONG KARBIN: *see* Ban Kabin Buri

- MUONG MO, Tonkin, Viet Nam: 22° 12' N., 102° 56' E.  
MUONG MOUN, Tonkin, Viet Nam: 21° 36' N., 103° 20' E.  
MUONG SEN, Vinh, Viet Nam: 19° 32' N., 104° 07' E.  
MUONG YO, Laos: 21° 28' N., 101° 52' E.  
MUPIN: *see* Muping  
MUPING, Szechwan, China: 30° 29' N., 102° 49' E.  
MYAWADI, Burma: 16° 41' N., 98° 31' E.  
MYITKYINA, Burma: 25° 24' N., 97° 26' E.  
NAGARJUN, Katmandu, Nepal: 27° 45' N., 85° 22' E.  
NAGCHUKA: *see* Hokow  
NAGGENJUNG: *see* Nagarjun  
NA HAI, Tonkin, Viet Nam: 21° 12' N., 102° 55' E.  
NAKHON PATHOM, Lum Phaya, Thailand: 13° 50' N., 100° 05' E.  
NAKHON SAWAN, Thailand: 15° 41' N., 100° 07' E.  
NAKHON SI THAMMARAT, Thailand: 8° 26' N., 99° 58' E.  
NAKONRAJASIMA [Nakhon Ratchasima], Thailand: 14° 57' N., 102° 05' E.  
NAKON SAWAN: *see* Nakhon Sawan  
NAM CHUH: *see* Ban Nam Chut Yai  
NAM FONG, Hainan, China: 19° 24' N., 109° 33' E.  
NAM KHUENG, Laos: 20° 25' N., 100° 18' E.  
NAM NEN, Tonkin, Viet Nam: circa 21° 40' N., 103° 15' E.  
NAM TAMAI VALLEY, Burma: 27° 42' N., 97° 54' E.  
NAM TING, Yunnan, China: 23° 31' N., 99° 06' E.  
NAM-TING RIVER at Burma Border, China: 23° 23' N., 98° 43' E.  
NAN: *see* Muang Nan  
NAN-TOU HSIEN, Wu Sheh, Taiwan, China: 23° 54' N., 120° 42' E.  
NANYASEIK, Burma: 25° 37' N., 96° 36' E.  
NAPÉ, Laos: 18° 20' N., 105° 05' E.  
NARATHIWAT, Thailand: 6° 25' N., 101° 50' E.  
NA TEBBU LAND, Wantsang Ku, Kansu, China: circa 34° 00' N., 101° 30' E.  
NAUSWA, Burma: 25° 40' N., 95° 20' E.  
NAWAKOT, Nepal: 27° 56' N., 85° 10' E.  
NAWOCOT: *see* Nawakot  
N'BUNGHKU, Burma: 25° 54' N., 96° 12' E.  
NELLIAMPATHI HILLS, India: 10° 30' N., 76° 35' E.  
NGAI TIO, Tonkin, Viet Nam: 22° 35' N., 103° 45' E.  
NGAN-SON, Tonkin, Viet Nam: 22° 25' N., 106° 00' E.  
NGAPYINIUN, Burma: 22° 32' N., 96° 00' E.  
NGAU-TCHI-LEA (Mts.), Hainan, China: 19° 00' N., 109° 30' E.  
NGHIA HUNG, Phu Qui, Annam: 19° 20' N., 105° 20' E.  
NGOLOSHI: *see* Tsungshi  
NGU-LUKO, Yunnan, China: 27° 03' N., 100° 12' E.  
NHATRANG, Annam, Viet Nam: 12° 15' N., 109° 15' E.  
NIKAWERATIYA, Ceylon: 07° 44' N., 80° 08' E.  
NIKAWEWA, near Kantalai, Ceylon: 08° 16' N., 81° 01' E.  
NIMROD SOUND, Chekiang, China: 29° 40' N., 121° 50' E.  
NINGPO, Chekiang, China: 29° 53' N., 121° 33' E.  
NINGYUANFU, Szechwan, China: 27° 55' N., 102° 18' E.  
NINGYUEN FU: *see* Ningyuanfu  
NINH HOA, Annam, Viet Nam: 12° 30' N., 109° 10' E.

- NODOA, Hainan, China: 19° 31' N., 109° 34' E.  
NOKREK, India: 25° 28' N., 90° 19' E.  
NONG BUA: *see* Ban Nong Bua  
NONG DOM TA: *see* Ban Nong Don Ta  
NONGKAI: *see* Muang Nong Khai  
NONGKHOR: *see* Ban Nong Kho  
NONG LUM, Tonkin, Viet Nam: 22° 22' N., 102° 53' E.  
NONGPOH, Assam, India: 25° 55' N., 91° 51' E.  
NONGSTOIN, Assam, India: 25° 31' N., 91° 16' E.  
NONG YANG, Thailand: 13° 10' N., 101° 30' E.  
NUA CHUA CHAN, Bien Hoa Prov., Viet Nam: 10° 56' N., 107° 23' E.  
NUI KAI, Yunnan, China: 26° 05' N., 100° 00' E.  
NYETMAW RIVER, Burma: 26° 05' N., 98° 18' E.  
OKMA, Burma: 22° 35' N., 94° 56' E.  
OK PYAM: *see* Pyam  
OK YAM: *see* Pyam  
OOTACAMUND, Nilgiri Hills, India: 11° 24' N., 76° 44' E.  
PA HAM, Tonkin, Viet Nam: circa 21° 35' N., 102° 55' E.  
PAHPOON: *see* Papun  
PAH TOOP: *see* Pha Tup  
PAKCHAN: *see* Ban Pak Chan  
PAK CHONG: *see* Ban Pak Chong  
PAKHA: *see* Pa Kha  
PA KHA, Tonkin, Viet Nam: 22° 33' N., 104° 18' E.  
PAK HIN BUN, Laos: 17° 35' N., 104° 40' E.  
PAK JONG: *see* Ban Pak Chong  
PAK KOH, Thailand: 18° 02' N., 99° 53' E.  
PAKNAMPHO: *see* Ban Pak Nam Pho  
PAK-SÉ, Laos: 15° 09' N., 105° 45' E.  
PAKSONG, Laos: 15° 15' N., 106° 07' E.  
PAK THA, Thailand: circa 18° 00' N., 100° 00' E.  
PAK THA PUJEG: *see* Ban Pak Tho  
PALASBARI, Assam, India: 26° 10' N., 91° 35' E.  
PALGHAT, Malabar, India: 10° 40' N., 76° 35' E.  
PALNI HILLS, Madura Dist., Madras, India: circa 10° 20' N., 77° 30' E.  
PANG MAE TON, Chiang Mai, Thailand: 18° 55' N., 99° 15' E.  
PANG ME TON: *see* Pang Mae Ton  
PANG NAM UN, Nan, Thailand: circa 18° 30' N., 100° 33' E.  
PANG SOK: *see* Sathani Pang Sok  
PANTHA, Burma: 23° 50' N., 94° 31' E.  
PAOTARAM: *see* Sathani Photharam  
PAPUN, Burma: 18° 05' N., 97° 22' E.  
PASA, Laos: 19° 40' N., 102° 25' E.  
PASBOK, Darjeeling, Bengal, India: 27° 10' N., 88° 25' E.  
PATTIPOLA, Ceylon: 06° 51' N., 80° 50' E.  
PEMIONCHEE, Sikkim, India: 27° 20' N., 88° 17' E.  
PENNAN (or PANGAN) ISLAND, Siam: *see* Ko PHANGAN  
PHANRANG, Annam, Viet Nam: 11° 34' N., 108° 59' E.  
PHA TUP, Northern Thailand: South of Muang Nan  
PHAWZAW, Burma: 25° 28' N., 95° 20' E.



- PHITSANULOK, Siam:  $16^{\circ} 50' N.$ ,  $100^{\circ} 15' E.$   
 PHONG SALY, Laos:  $21^{\circ} 42' N.$ ,  $102^{\circ} 09' E.$   
 PHONG THO, Tonkin, Viet Nam:  $22^{\circ} 20' N.$ ,  $103^{\circ} 20' E.$   
 PHRA NAKHON SI AYUTTHAYA, Ayutthaya, Thailand:  $14^{\circ} 20' N.$ ,  $100^{\circ} 35' E.$   
 PHU DO, Kan Luang, Nakon Phanom, Thailand: circa  $16^{\circ} 55' N.$ ,  $104^{\circ} 30' E.$   
 PHUKET ISLAND: *see* Ko Phuket  
 PHU KHO, Kan Luang, Nakon Phanom, Thailand: circa  $16^{\circ} 55' N.$ ,  $104^{\circ} 30' E.$   
 PHU KOBO, Laos:  $19^{\circ} 22' N.$ ,  $103^{\circ} 23' E.$   
 PHU PHAN, Sakon Nakon, Thailand:  $16^{\circ} 52' N.$ ,  $104^{\circ} 23' E.$   
 PHU QUI, Annam, Viet Nam:  $19^{\circ} 25' N.$ ,  $105^{\circ} 22' E.$   
 PIAM: *see* DELISLE  
 PICHET: *see* Ban Nai Muang  
 PIEN NGAI, Szechwan, China:  $29^{\circ} 12' N.$ ,  $108^{\circ} 10' E.$   
 PING TUNG, Taiwan, China:  $22^{\circ} 40' N.$ ,  $120^{\circ} 30' E.$   
 PINTENNE, Ceylon:  $07^{\circ} 21' N.$ ,  $81^{\circ} 00' E.$   
 PITSANULOK: *see* Muang Phitsanulok  
 PLATEAU BOLOVENS, Laos:  $15^{\circ} 10' N.$ ,  $106^{\circ} 20' E.$   
 POI, Assam, India:  $25^{\circ} 20' N.$ ,  $94^{\circ} 37' E.$   
 PONMUDI, Travancore, India:  $08^{\circ} 44' N.$ ,  $77^{\circ} 07' E.$   
 POOKEIO: *see* Ban Phu Kheio  
 POOKEIOCHAIYABHOM: *see* Ban Phu Kheio  
 POOTOO: *see* Puto Shan  
 POTARAM: *see* Sathani Photharam  
 POWAI: *see* Poi  
 PRA (Mt.), Cambodia:  $12^{\circ} 38' N.$ ,  $103^{\circ} 02' E.$   
 PRACHUAP KHIRI KHAN, Thailand:  $11^{\circ} 50' N.$ ,  $99^{\circ} 50' E.$   
 PRAN: *see* Prachuap Khiri Khan and Pran Buri  
 PRAN BURI, Prachuap Khiri Khan, Thailand:  $12^{\circ} 22' N.$ ,  $99^{\circ} 56' E.$   
 PRAPOOT MT.: *see* Khao Phra Phut  
 PRAPOOTABAT: *see* Khao Phra Phut  
 PROME, Burma:  $18^{\circ} 50' N.$ ,  $95^{\circ} 14' E.$   
 PUA: *see* Ban Pua  
 PUCHENG, Fukien, China:  $28^{\circ} 05' N.$ ,  $118^{\circ} 28' E.$   
 PUJEG: *see* Pujek  
 PUJEK, Pak Tho, Rajburi, Thailand:  $13^{\circ} 23' N.$ ,  $99^{\circ} 42' E.$   
 PUKPITIYA: *see* Puwakpitiya  
 PULO BEMAN: *see* Clara Island  
 PULO KETCHEN: *see* St. Lukes Island  
 PULO LAMBI: *see* Sullivan's Island  
 PULO SALAKRING: *see* Hastings Island  
 PUM-KATONG, Burma:  $25^{\circ} 23' N.$ ,  $97^{\circ} 44' E.$   
 PUMSIN, Burma:  $25^{\circ} 57' N.$ ,  $96^{\circ} 11' E.$   
 PUTO SHAN, Chusan Archipelago, Chekiang, China:  $30^{\circ} 00' N.$ ,  $122^{\circ} 25' E.$   
 PUWAKPITIYA, Gammaduwa, Ceylon:  $07^{\circ} 36' N.$ ,  $80^{\circ} 43' E.$   
 PYAM, Kampot, Thailand:  $11^{\circ} 37' N.$ ,  $102^{\circ} 56' E.$   
 PYAUNGBYIN, Burma:  $24^{\circ} 15' N.$ ,  $94^{\circ} 47' E.$   
 PYAUNGGAUNG, Burma:  $22^{\circ} 35' N.$ ,  $97^{\circ} 05' E.$   
 PYEPAT, Burma:  $25^{\circ} 54' N.$ ,  $98^{\circ} 15' E.$   
 PYNURSLA, Assam, India:  $25^{\circ} 18' N.$ ,  $91^{\circ} 53' E.$   
 QUANGTRI PHUOC MON, Annam, Viet Nam:  $16^{\circ} 35' N.$ ,  $107^{\circ} 10' E.$

- QUANG TRI RIVER, Annam, Viet Nam: circa 16° 46' N., 107° 11' E.  
 RACU RACU MOUNTAINS: *see* Rakuraku  
 RAHENG: *see* Ban Rahaeng  
 RAHNAMPO: *see* Ban Pak Nam Pho  
 RAJABURI: *see* Rat Buri  
 RAJBURI: *see* Ban Pong  
 RAKURAKU, Taiwan, China: 23° 27' N., 121° 30' E.  
 RAMA LA PASS, Szechwan, China: 29° 40' N., 100° 25' E.  
 RANGOON, Burma: 16° 47' N., 96° 10' E.  
 RANNA, Ceylon: 06° 05' N., 80° 55' E.  
 RAT BURI, Thailand: 13° 32' N., 99° 49' E.  
 RATNAMTI, Burma: 27° 35' N., 97° 55' E.  
 RED POINT, Tenasserim, Burma: 10° 40' N., 98° 30' E.  
 RINGIN, Sikkim, India: 27° 30' N., 88° 30' E.  
 RIRI BAZAAR, Nepal, India: 27° 55' N., 83° 22' E.  
 RUMITCHANGU, Szechwan, China: 30° 50' N., 102° 05' E.  
 RUNGBONG VALLEY, Sikkim, India: 26° 50' N., 88° 13' E.  
 SADIYA, Assam, India: 27° 50' N., 95° 45' E.  
 ST. LUKES ISLAND, Burma: 10° 05' N., 98° 15' E.  
 SAKEO: *see* Ban Sa Kaeo  
 SAKERAT: *see* Ban Chakkrarat  
 SALANGA: *see* Koh Phuket  
 SALANGKA: *see* Koh Phuket  
 SALWEEN-MEKONG DIVIDE at 28° 20' N.: 28° 20' N., 98° 35' E.  
 SAMASGI, Dharwar-Kanara border, India: 14° 40' N., 75° 00' E.  
 SAMBOR, Cambodia: 12° 45' N., 105° 59' E.  
 SAM ROI GOP: *see* Sathani Sam Roi Yot  
 SANGAU, Assam, India: 21° 44' N., 93° 03' E.  
 SANGSIR: *see* Singsir  
 SATA HIP: *see* Ban Sattahip  
 SATHANI HIN LAP, Thailand: 14° 40' N., 101° 10' E.  
 SATHANI LAMPHURA, Thailand: 07° 40' N., 99° 35' E.  
 SATHANI PANG HUA PHONE, Thailand: 18° 25' N., 99° 15' E.  
 SATHANI PANG SOK, Sara Buri, Thailand: 14° 40' N., 101° 20' E.  
 SATHANI PHOTHARAM, Rat Buri, Thailand: 13° 40' N., 99° 50' E.  
 SATHANI SAM ROI YOT, Thailand: 12° 15' N., 99° 55' E.  
 SATHANI THA CHOMPHU, Lamphun, Thailand: 18° 30' N., 99° 15' E.  
 SATHANI THUNG SONG, Nakhon Si Thammarat, Thailand: 08° 10' N., 99° 40' E.  
 SATTHA HILL: *see* Satthar  
 SATTHAR, Nepal: 28° 01' N., 84° 35' E.  
 SAWANKALOKI: *see* Ban Wang Mai Khon  
 SAWANKHALOK: *see* Ban Wang Mai Khon  
 SEECHOL: *see* Ban Sichon  
 SEDONCHEN, Sikkim, India: 27° 30' N., 88° 30' E.  
 SE'EN, N. Shan States, Burma: 22° 39' N., 97° 22' E.  
 SENIKU, Burma: 25° 34' N., 97° 47' E.  
 SEVOKE, Bengal Presidency, Pakistan: 26° 51' N., 88° 32' E.  
 SHANDAW, Burma: 17° 55' N., 95° 40' E.  
 SHANGHAI, China: 31° 13' N., 121° 25' E.  
 SHANG KUAN, Yunnan, China: 25° 55' N., 100° 05' E.

- SHIHPINGCHOW, Yunnan, China: 23° 40' N., 102° 25' E.  
SHINEI, Formosa, China: 23° 18' N., 120° 18' E.  
SHINEIGUN: *see* Shinei  
SHINGBWIYANG, Hukawng Valley, Burma: 26° 41' N., 96° 12' E.  
SHOO-O-LO: *see* Siolo  
SHRIVILLIPUTTUR [Srivilliputtur], Madras, India: 07° 30' N., 77° 38' E.  
SHUAN LUNG CHANG, Kweichow, China: 28° 05' N., 106° 48' E.  
SHUI-KOW-KWAN: *see* Lungchow  
SHWEBO, Burma: 22° 35' N., 95° 42' E.  
SHWELI VALLEY, Yunnan, China: circa 25° 00' N., 98° 40' E.  
SHWELI-SALWEEN DIVIDE, Yunnan, China: circa 25° 05' N., 98° 45' E.  
SIAOMENG TUNG, Yunnan, China: 24° 10' N., 99° 15' E.  
SIEM REAP, Cambodia: 13° 20' N., 103° 51' E.  
SIKEN: *see* Ban Si Khiu  
SIKEU: *see* Ban Si Khiu  
SIMA, Myitkyina, Burma: 25° 05' N., 97° 35' E.  
SINGKALING HKAMTI, Burma: 26° 00' N., 95° 39' E.  
SINGSIR, Bengal Presidency, India: 27° 04' N., 88° 35' E.  
SINGTAM, Sikkim, India: 27° 14' N., 88° 33' E.  
SINKAI, Yunnan, China: 24° 12' N., 102° 04' E.  
SILO, Szechwan, China: 30° 02' N., 100° 48' E.  
SIRACHA: *see* Ban Si Racha  
SIRSA, Hissar, Punjab, Pakistan: 29° 30' N., 75° 00' E.  
SISAGARHI, Nepal: 27° 25' N., 85° 05' E.  
SLOKBAI: *see* Ban Salok Bat  
SOKOTAI: *see* Ban Thani  
SOOKIA POKHARI, Darjeeling, India: 27° 02' N., 88° 14' E.  
SOOKLI: *see* Sukli  
SOUTH CAPE OF FORMOSA, China: 21° 54' N., 120° 52' E.  
SRIRACHA: *see* Ban Si Racha  
SUCHOW, Szechwan-Yunnan border, China: 28° 43' N., 104° 32' E.  
SUIFU: *see* Suchow  
SUIYANG, Kweichow, China: 27° 50' N., 107° 18' E.  
SUKHOTHAI: *see* Ban Thani  
SUKIAPOKHRI: *see* Sookia Pokhari  
SUKLI, Myawadi Rd., Burma: 16° 42' N., 98° 22' E.  
SULLIVAN'S ISLAND, Mergui Archipelago, Burma: 10° 40' N., 97° 58' E.  
SUMKA UMA, Burma: 25° 57' N., 97° 49' E.  
SUMPRABUM, Burma: 26° 38' N., 97° 36' E.  
SUNGEI BALIK, Tenasserim, Burma: 10° 31' N., 98° 33' E.  
SUNG PAN, Szechwan, China: 32° 41' N., 103° 21' E.  
SUNJANG: *see* Suiyang  
SUNG SHAN, Honan, China: 34° 35' N., 113° 20' E.  
TA CHANG TAI: *see* Tha Chang Tai  
TA CHIAO, Szechwan, China: circa 30° 03' N., 103° 13' E.  
TACHIN: *see* Ban Maha Chai  
TAGA HKA, Burma: 26° 22' N., 96° 07' E.  
TAGOOT, Burma: 10° 25' N., 99° 18' E.  
TA-HO: *see* Ta Ho-Hta  
TA HO-HTA, Independent Kareni, Burma: 19° 06' N., 97° 30' E.

- TAINAN, Taiwan, China: 23° 00' N., 120° 12' E.  
 TAI-PA-SHIANG MTS.: *see* Tapa shan  
 TAIPEI, Taiwan, China: 25° 05' N., 121° 32' E.  
 TAIPEI HSIEN, Wu Lai, Taiwan, China: 24° 50' N., 121° 32' E.  
 TAI-PEI-SHAN DISTRICT, Shensi, China: 33° 56' N., 107° 41' E.  
 TAI-PING-PU, Yunnan, China: 24° 57' N., 98° 42' E.  
 TAI-YUAN-FU, Shansi, China: 37° 53' N., 112° 29' E.  
 TAK: *see* Ban Rahaeng  
 TAKUBAMA, Assam, India: 25° 50' N., 94° 28' E.  
 TAMABIN, Burma: circa 17° 45' N., 96° 30' E.  
 TAMANTHI, Burma: 25° 20' N., 95° 12' E.  
 TAM DAO, Tonkin, Viet Nam: 21° 30' N., 105° 38' E.  
 TAMU, Burma: 25° 45' N., 98° 02' E.  
 TANGA, Burma: 25° 50' N., 98° 05' E.  
 TANGSHU, Gieu Long Shien, Tibet: 28° 58' N., 98° 08' E.  
 TANG GU: *see* Tangshu?  
 TANJONG BADAQ, Tenasserim, Burma: 10° 06' N., 98° 29' E.  
 TAOK, Tenasserim, Burma: 16° 20' N., 98° 28' E.  
 TAO MUNG CHUNG, Lu-tien, Yunnan, China: 27° 12' N., 103° 31' E.  
 TAPA HKA, Burma: 26° 07' N., 96° 15' E.  
 TAPA SHAN, Shensi, China: 32° 40' N., 107° 30' E.  
 TAPPAN-SHA, Formosa, China: 23° 28' N., 120° 44' E.  
 TAPPOSHA: *see* Tappan-sha  
 TARKHOLA, Sikkim, India: 27° 07' N., 88° 33' E.  
 TAROAR: *see* Tagoot  
 TARON VALLEY, Burma: circa 28° 00' N., 98° 10' E.  
 TA-SHUI-TANG: *see* Tashutang  
 TASHUTANG, Yunnan, China: 24° 17' N., 99° 15' E.  
 TASU BUM, Burma: 26° 04' N., 96° 14' E.  
 TATKON, Burma: 23° 45' N., 94° 23' E.  
 TATSIENTLU, Szechwan, China: 30° 03' N., 102° 13' E.  
 TAUKECHANDMAI, Burma: 23° 30' N., 94° 35' E.  
 TAVOY, Burma: 14° 07' N., 98° 18' E.  
 TAVOY ISLAND, Mergui Archipelago, Burma: 11° 00' N., 98° 20' E.  
 TAWMAW, Burma: 25° 44' N., 96° 18' E.  
 TAY NINH, Cochin China, Viet Nam: 11° 12' N., 106° 02' E.  
 TEHAN, China: circa 30° 20' N., 117° 20' E.  
 TELLULA, Ceylon: 06° 36' N., 81° 08' E.  
 TELOK BESAR, Tenasserim, Burma: 10° 22' N., 98° 35' E.  
 TEMPAAO, Burma: 24° 59' N., 94° 56' E.  
 TENASSERIM TOWN, Burma: 12° 06' N., 99° 03' E.  
 TENG YUEH, Yunnan, China: 25° 00' N., 98° 30' E.  
 TERASO: *see* Teraso Soan  
 TERASO SOAN, Formosa, China: 22° 01' N., 120° 51' E.  
 THA CHANG: *see* Ban Tha Chang  
 THA CHANG TAI, Tak, Thailand: 16° 51' N., 99° 03' E.  
 THAGYET, Burma: 12° 06' N., 99° 06' E.  
 THAI NGUYEN, Tonkin, Viet Nam: 21° 30' N., 105° 55' E.  
 THAI NIEN: *see* Thai Nguyen  
 THALE SONG HONG, Thailand: 7° 50' N., 99° 27' E.



- THAMAUNG: *see* Thandaung  
THANDAUNG, Burma: 19° 05' N., 96° 38' E.  
THAN HOA, Annam, Viet Nam: 19° 49' N., 105° 48' E.  
THA RONG: *see* Ban Wichian  
THATENG: *see* Ban Thateng  
THATON, Burma: 16° 50' N., 97° 18' E.  
THATONE: *see* Thaton  
THAUNGYIN VALLEY, Tenasserim, Burma: circa 16° 42' N., 98° 30' E.  
THENG-GAN-NGOK, Tenasserim, Burma: 13° 20' N., 98° 55' E.  
THOBAL, Manipur, India: 24° 18' N., 94° 02' E.  
THOTEL: *see* Thobal  
THOWNGYOH: *see* Theng-gan-ngok  
THUA LUU, Annam, Viet Nam: circa 16° 19' N., 108° 00' E.  
THUANGYIN VALLEY: *see* Thauingyin Valley  
TIENCHUAN, Szechwan, China: 30° 05' N., 103° 00' E.  
TINGCHOW, Hopeh, China: 38° 30' N., 115° 02' E.  
TINGCHOWFU, Fukien, China: 25° 44' N., 116° 27' E.  
TINNPANI: *see* Tirappane  
TIRAPPANE, Ceylon: 08° 12' N., 80° 31' E.  
TI-YU GOMBA, Yunnan [Sikang], China: circa 28° 40' N., 101° 10' E.  
TONGKA: *see* Koh Phuket  
TOONG, Sikkim, India: 27° 35' N., 88° 40' E.  
TORSAN: *see* Ban Tha San  
TOUNGOO, Burma: 18° 55' N., 96° 25' E.  
TRA KHANUN: *see* Ban Tha Khanum  
TRANG BOM, Cochinchina, Viet Nam: 10° 50' N., 107° 00' E.  
TRASHI-CHO-TEN, Szechwan, China: circa 30° 20' N., 102° 20' E.  
TRIVANDRUM, Travancore, India: 08° 29' N., 76° 55' E.  
TSAO PO, Szechwan, China: 21° 05' N., 103° 31' E.  
TSE-KOW: *see* Tseku  
TSEKU, Yunnan, China: 28° 00' N., 98° 52' E.  
TSEO JIA KEO, Szechwan, China: circa 28° 18' N., 104° 12' E.  
TSINGKIEN, Shensi, China: 37° 12' N., 110° 12' E.  
TSING-LING MTS., Shensi, China: circa 33° 00' N., 108° 00' E.  
TSINGTEH, Anhwei, China: 30° 23' N., 118° 30' E.  
TSONMA, Burma: 26° 10' N., 98° 35' E.  
TSUK KON SHIH: *see* Tungshih  
TSUNGSHI: *see* Tungshih  
TSUNYI HSIEN, Kweichow, China: 27° 35' N., 107° 02' E.  
TUNG-LING: *see* Eastern Tombs  
TUNGLU, Chekiang, China: 29° 47' N., 119° 37' E.  
TUNG NOC KARIEN, Jombing, Rajburi, Thailand: 13° 33' N., 99° 35' E.  
TUNG SAWN: *see* Sathani Thung Song  
TUNGSHIH, Hupeh, China: 30° 22' N., 111° 42' E.  
TUNGTZE, Kweichow, China: 27° 58' N., 106° 51' E.  
TUNG WONG TIEN, Kweichow, China: 28° 03' N., 105° 50' E.  
TU-PA-KEO, Moupin, Szechwan, China: circa 30° 30' N., 102° 45' E.  
TURA, Garo Hills, Assam, India: 25° 31' N., 90° 16' E.  
UKHRUL, Manipur, India: 25° 10' N., 94° 18' E.  
ULONGKONG, Szechwan, China: circa 29° 55' N., 102° 10' E.

- UM PANG: *see* Ban Le Kathe  
 UMRAN, Assam, India: 25° 65' N., 91° 50' E.  
 UTTARADIT, Thailand: 17° 38' N., 100° 06' E.  
 VAN LUNG, Thanhhoa, Annam, Viet Nam: 20° 30' N., 104° 40' E.  
 VICHIANBURI: *see* Ban Wichian  
 VICTORIA POINT, Tenasserim, Burma: 10° 00' N., 98° 30' E.  
 VIENTIANE, Laos: 17° 45' N., 102° 40' E.  
 WAN MTS., Anwei, China: circa 30° 45' N., 117° 55' E.  
 WANG KIEN: *see* Kanchanaburi  
 WAN HSIEN, Szechwan, China: 30° 49' N., 108° 23' E.  
 WAN-TIEN, Yunnan, China: 24° 31' N., 99° 21' E.  
 WA SHAN, Szechwan, China: circa 29° 25' N., 104° 20' E.  
 WATERFALL, Mekang: *see* Ban Mae Klang  
 WA TIEN, China: 25° 20' N., 98° 36' E.  
 WEI CHOW: *see* Weikiu  
 WEIKIU, Szechwan, China: 31° 25' N., 103° 28' E.  
 WEISI PASS, Yunnan, China: 27° 14' N., 99° 27' E.  
 WELLAWAYA, Uva Prov., Ceylon: 06° 43' N., 81° 06' E.  
 WENCHWAN, Szechwan, China: 31° 20' N., 103° 31' E.  
 WEN-SHUI, Kweichow, China: 28° 25' N., 106° 18' E.  
 WESTERN HILLS, 15 mi. W. of Peking, Hopeh, China: 39° 57' N., 116° 07' E.  
 WIE SHI PASS: *see* Weisi Pass  
 WU-CHI: *see* Wushi  
 WUCHI SHAN, Hainan, China: 18° 55' N., 109° 20' E.  
 WUNG PRATART FARM, Kam Peng Pet, Thailand: 16° 10' N., 99° 45' E.  
 WUNTHO, Burma: 23° 56' N., 95° 45' E.  
 WUSHI, Yunnan, China: 29° 05' N., 101° 28' E.  
 WUTAI, Shansi, China: 38° 55' N., 113° 38' E.  
 WUTINGCHOW, Yunnan, China: 25° 30' N., 102° 26' E.  
 WUTING HSIEN: *see* Wutingchow  
 WU-TING-SHAN, Jehol, Manchuria: 40° 42' N., 117° 21' E.  
 WU-TSAI: *see* Wutai  
 XIENG KHOUANG, Laos: 19° 25' N., 103° 25' E.  
 XIEN QUANG KOO: *see* Xieng Khouang  
 YACHOW: *see* Yachowfu  
 YACHOWFU, Szechwan, China: 29° 59' N., 103° 10' E.  
 YALUNG RIVER, S.W. Szechwan, China: circa 27° 10' N., 101° 50' E.  
 YANGWUPA, Yunnan, China: 23° 56' N., 102° 10' E.  
 YAO-SHAN, Kwangsi, China: 24° 00' N., 110° 00' E.  
 YELLAPUR, Bombay, India: 14° 55' N., 74° 40' E.  
 YEN-AN-FU, Shensi, China: 36° 44' N., 109° 25' E.  
 YENPING, Fukien, China: 26° 38' N., 118° 10' E.  
 YIN, Burma: 22° 43' N., 94° 42' E.  
 YIU SHAN: *see* Yu Shan  
 YUKI, Fukien, China: 25° 28' N., 119° 18' E.  
 YULONG-VLANG: *see* Ulongkong  
 YUNG CHA SHAN, Szechwan, China: 29° 23' N., 108° 10' E.  
 YUNGHTANG, Burma: 27° 38' N., 98° 03' E.  
 YUNG-NING, Yunnan, China: 27° 45' N., 100° 41' E.  
 YUNGPEH, Szechwan, China: 26° 40' N., 100° 45' E.

YUNG-PEI-TING: *see* Yungpeh

YUNNANFU, Yunnan, China: 25° 00' N., 102° 40' E.

YUNNANYI, Yunnan, China: 25° 25' N., 100° 37' E.

YU SHAN, Kwangtung, China: 24° 42' N., 114° 10' E.

ZAMAYI RES., Pegu Yoma, Burma: 18° 21' N., 95° 59' E.

ZAMI RIVER, 100 miles south of Moulmein, Burma: 15° 25' N., 98° 25' E.

ZAULEP GA, Burma: circa 25° 57' N., 96° 11' E.

ZAUNGTU, Burma: circa 17° 50' N., 96° 30' E.

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